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Engineering News-Record

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Water-Works Number

Between the covers of the present issue will be found many articles ranging over the whole water-works field, both geographically and technically. They are presented at this time because of the annual convention of the American Water-Works Association at Buffalo next week. A few of the many water-works topics presented in this issue, and some of the other leading subjects, are outlined below:

Ancient, War-Time and Present Water-Supply in Jerusalem

How General Allenby's engineers brought water from the Nile across the desert—The ancient and new permanent water-supplies of Jerusalem—Important part played by caterpillar tractors and modern pipe

By H. Y. CARSON

New Coal-Handling Plants for Philadelphia Water-Works

General and detail design of three systems supplying a total of 16 boilers with a total boiler capacity of 7400 horsepower—Costs reduced as compared with old methods

By HARRISON R. CADY

Centrifugal Pumps at the Chicago Water-Works Plants

Electric power more satisfactory than steam—Two 40,000,000-gallon pumps with 1100-horsepower motors being installed

The Numerical Interpretation of Bacteriological Tests

Theory of probabilities applied to sanitary engineering, with particular reference to results of water and sewage studies

By MILTON F. STEIN

Water-Meter Practice and Testing at Buffalo

Special testing bench for large meters, cubic foot pail for skeptical householders, and non-freeze settings

By CARL L. LUND

A Water-Waste Inspectress Hunting Leaks at Baltimore

Women Water-Waste Inspectors at Baltimore

Men replaced with satisfactory results—Women under direction of pitometer engineer paid $2.76 a day

By WALTER E. LEE

Design and Tests of Highly Efficient Air-Lift Installation at Fort Bliss

Novel foot piece, well proportioned eduction pipe, and special head tanks give 51.9 per cent. air-lift efficiency—Overall efficiency 28.6 per cent.—Test figures for two methods and operating costs given

By CAPT. J. F. BROWN

Study of Revenue from the Sale of Water to Metered Domestic Consumers

New England Water-Works Association form based on service and output charge alone rational and equitable—Basing revenue estimates on unregistered water leads to error

By PHILIP BURGESS

Handling Iron Ore at the Head of the Great Lakes

How ore of many different compositions, from hundreds of mines, is delivered rapidly to boats in required analyses

By GEORGE H. HERROLD

Supporting Blast Furnace While Replacing Foundation

Well braced timber trusses and old crane girder utilized—Cracked brickwork renewed by concrete, using skip bridge

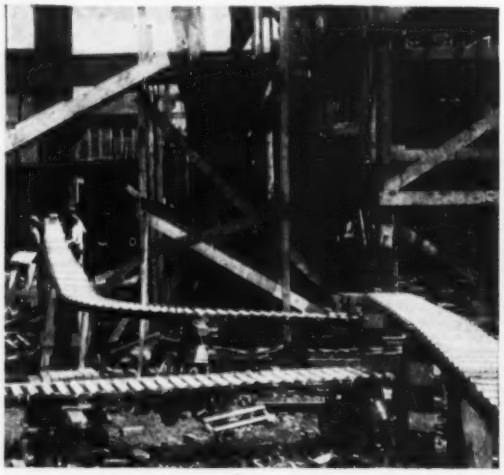
By C. W. LUSH

Underwater Construction of Outshore Launching Ways

Speed and economy of work at Bristol justified choice of diver method in place of cofferdam construction—Special rig for use in placing pile caps

By E. D. BUEL

June 5, 1919



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E. J. MEHREN, *Editor* — CHARLES WHITING BAKER, *Consulting Editor*

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Chicago Leads in Centrifugal Pumping

BY FAR the largest aggregation of centrifugal pumping machinery for water-works purposes is that of Chicago, which includes 16 plants having a combined capacity of about 400,000,000 gal. per day, with over 60% of the volume lifted electrically. The record of the growth of the Chicago installation, given on p. 1114, is a chapter in the development of large centrifugal pumping units for water-works plants that is well worth reading.

Water-Works Association Growth

GROWTH has been shown by the American Water-works Association for several years. This applies both to numbers and efficiency, but perhaps more notably to membership and to sectional organization than to the volume and character of work done. In fact, even before we got into the war there appeared to be a decline in accomplishments, at least as regards committee work. Naturally, the war checked committee work still further. It should now be resumed along well considered lines and with vigor. In particular, the committee on cast-iron pipe specifications should complete its work of revision and of unification of the American and New England specifications. There might well be a committee on methods of paying for water-main extensions, directed to gather extensive data on methods in use, to compare the merits and demerits of the several plans and to draw conclusions as to the best plan, or the most desirable plans from which to choose, to meet prevalent types of local conditions. In such a study particular attention should be given to assessments for benefits. These are only two of many kinds of committee work that might be mentioned as possibilities.

Public Service Through Technical Discussion

NOT often does an engineering society give such direct service to the community through technical discussion as did the American Society of Civil Engineers with its recent symposium on the Hudson River highway tunnel, recorded in the May *Proceedings* of the society. By taking up an urgent problem, one of exceptionally formidable engineering aspect, and giving opportunity for the free expression and clarification of opinion on its solution, the society afforded important help to the community in its largest present enterprise. Coming at the time when the technical organization of the Hudson tunnel work is being perfected, the discussion will almost at once produce a tangible gain to the community. It marks out the field within which must develop the final solution of the tunnel-construction problem on which New York and New Jersey have just agreed, and thereby it gives to the public the advantage of surer engineering decision, which will mean more efficient performance. Furthermore, the facts and views brought out in the symposium establish, if one will read between the lines, the urgent need for better intercommunication between New York City and its New Jersey outliers more convincingly than has yet been done. They tend to define the land-traffic problem of this terminal as a unit problem—one of great magnitude—and raise the question whether the trans-Hudson traffic situation is not more serious than even the most ardent advocates of bridge and tunnel projects have yet ventured to claim. The issues here, involving additional crossings of the river and elaborate connections for these crossings, are so weighty that only by focusing the full power of engineering thought upon the subject can a sound program of action be constructed. The society's discussion was the first step toward creating this condition.

Engineers for Hudson Tunnel

ANNOUNCEMENT has been made that six consulting engineers will be appointed to advise on the vehicular tunnel to be built under the Hudson between New York and Jersey City. Time was when it appeared that one plan—that for the 42-ft. single tube—had the clear right of way. Though proposed by an able tunnel builder and approved by an able engineer, obviously a project departing so far from standard practice requires not only close scrutiny in itself but detailed comparison with tried methods of construction. There are no less than four plans proposed, two concerned chiefly with type and two with construction methods—the large tube, a pair of tubes of customary size and two variants of the trench method of construction. Presumably, the engineers will be selected for their familiarity with the types of construction proposed; this, of course, does not apply to the large single tube, for that is unprecedented. The principle of the procedure is correct, that of a broad study of the question. If the appointments agree with the principle the commissioners will have competent data to guide their decision.

Municipal Rain-Gages

"THERE are far too few rainfall stations," said Robert E. Horton a few months ago (*Engineering News-Record* of Mar. 27, 1919, p. 614), in pointing out the inadequacy of our hydrological data. His statement has just had renewed illustration. During the heavy rainfalls of the past month many towns and cities reported short-time storms of unusual intensity. Rainfall rates exceeding any previously known are said to have occurred in some cities; tangible evidence such as the amount of water caught in vessels standing in the open confirms mere impression in this matter. Were local drainage works to be built in those cities, a definite measurement of the new maximum rainfall rate reached would be important, but for lack of a rain-gage no

measurement was obtained. A few cities maintain gages; most do not. May it not fairly be considered a proper municipal engineering function to provide rain gages and to keep exact records?

Flying the Atlantic

IN THE broad annals of engineering last week will mark an epoch. For the first time the Atlantic Ocean was crossed by man in the air. Those of us who have not followed closely the development of flying little appreciate the amount of painstaking engineering study and investigation that has gone into making that flight possible. We speak not of the details of Commander Read's crossing of the ocean, nor of the design of his plane and its accessories. We are thinking of all that has gone before in the way of study and experimentation, of the thousands of planes built only to be scrapped, of the thousands of lives that have been risked and lost in order that we might come to the NC-4 and her triumph. We are thinking, too, of our own Chanute and of Langley, of happy memory. Much as the thoroughness of the preparations, the weather reports and the bridge of ships extending from Newfoundland to the Azores, to Portugal and to England may detract from the possible romance of an Atlantic flight, the accomplishment is a tremendous one. It has furnished, so aëronautical experts tell us, many valuable data on which to base further oversea flying feats, and it will act as a stimulus for others to do their utmost, not merely to duplicate the feat, but to surpass it by a nonstop flight from land to land. From the historical standpoint, the outstanding fact is that the first successful flight from the Western to the Eastern continent—a distance by the Azores of 2150 nautical miles—was accomplished in 26 hours and 47 min. of actual flying time. Therein lies the compelling motive in the development of the method of flying—that it will bring the two continents much closer than they are today. Imaginations stirred by such an event can rove wildly, but he would be dull indeed who did not live in the expectation of mail transmission between Europe and America consummated in the space of a single day. As a regular method of postal conveyance, such a feat may be a few years off, but it has plainly been brought within the realm of probability.

City Planning Progress

TWENTY years ago city planning was a term rarely used in America, and then only by a few men who were almost universally held up to amusement or contempt as idle dreamers. Ten years ago the need for city planning had obtained sufficient recognition on this side of the Atlantic to warrant the holding of a conference on the subject. Similar conferences have been held year after year ever since. These have shown growth in numbers and in concreteness of discussion. At the start few engineers were in attendance. Year by year the number has increased, until, at the conference held May 26-29, 1919, at Niagara Falls, perhaps a fourth of the members were engineers. The proceedings of all the city planning conferences have dealt almost exclusively with severely practical matters, nearly all of which are within the engineering field as commonly understood and practically all of which are included within any broad view of municipal engineering. Of this no better evidence could be offered than the abstracts of conference papers and the report of the meeting given on pp. 1079 and 1133 of this issue. Many of the more progessive municipal engineers of the country are already members of the conference. The number should increase.

The Development Committee

AT MINNEAPOLIS there should be opportunity for crystallization of views with reference to the development committee of the American Society of Civil Engineers. The question should come up at the business session of the convention; it surely will in the corridor talk. In New York in January the preliminary report of the committee was passed without comment. No food for thought had been offered by the committee. The time available had been too short. The situation as far as it concerns measures proposed for discussion has not improved. But there is the difference that six months have gone by, six months that have multiplied questions as to what the development committee was doing and what good would come of it. In those six months, too, has come the demand that the executive power of the committee be changed at intervals. It will be singular indeed if after six months of silence the Minneapolis-St. Paul convention should pass without the taking of bearings on this important question.

Service Rather Than Honor

THE coming meeting of the nominating committee of the American Society of Civil Engineers makes apropos the repetition of a thought expressed at a meeting in New York in March. J. E. Johnson, Jr., since deceased, described many of the men elected to office in our national societies as men who had won reputations and who were afraid of damaging them by starting something new. While the particular turn he gave his thought renders it liable to dispute, it is true, as was expressed in these columns in the issue of Apr. 3, 1919, that in seeking to honor men by electing them to office we have at times sacrificed the interests of the societies. The older men have come to the time of life when they take up new problems with less energy, when the inclination is strong to be content with that which is. Age, however, is not essentially a disqualifier; rather, mental alertness and freshness of view are to be looked to. There are men who are old at 45 and others young at 70. The late Dr. Corthell, notably, belonged to the latter group. In these days, when new conditions are pressing upon us, the standard for selection, we should think, would be ability *and inclination* to serve the society.

Simpler Geometry of Compound Curves

ALTHOUGH the formulas for the treatment of the geometry of compound curves developed by Mr. Llano on page 1070 of last week's issue are not all new, they are apparently simpler theoretically and more convenient practically than any others heretofore developed. Being derived in a systematic way from a few sets of fundamental equations without the necessity of drawing special figures or going through any special investigations for every particular case, they make unnecessary the introduction of auxiliary quantities. They are an improvement over the methods adopted by other writers because they reduce to a minimum both the work itself and the probabilities of error. The apparent simplicity sometimes indicated in textbooks is often misleading, because when application is made it is found that the actual arithmetical work is exceedingly laborious and often involves much unnecessary duplication. While

compound curves are not now so frequently used in steam railroads, the spiral being generally resorted to as more efficient and economical, in minor roads and especially in street railways the compound circular curve is much used. Furthermore, in the original location of steam railroads running through open country, compound curves are usually determined by assuming the two radii and central angles and computing the tangent distances. Certain auxiliary circles given in the article will be found most helpful in the solution of such problems. In street railways, on account of limited space, many of the problems solved in this article are likely to arise. For example, in the construction of the Lexington Ave. cable road in New York City, the assumed directions of the tangents to connect with the Broadway line at 23d St. were found to interfere with the intricate system of water, gas, and electric pipes, making it necessary to change the alignment by swinging a tangent about one of the tangent points. This led to the solution of one of the problems given in the article.

Engineers Decline Executive Post

MUCH comment has been occasioned at New York by the reported refusal of certain New York engineers of the post of transit construction commissioner. They were good engineers, able executives, the comment runs—why, then, did they decline a post concerned exclusively with the execution of engineering work? We are not in a position to answer for the engineers in question, but we do know that the post is not an enviable one. All our readers will remember the hamstringing of the commission by the Board of Estimate and Apportionment when some 300 engineers were dropped last winter. It is a position of apparently large responsibility, with the incumbent's hands effectively tied, if the board wishes to tie them. The case, then, is not typical. It is likely to be a position beset with much grief.

Executive Versus Technical Ability

THE declination by engineers of the post of transit construction commissioner at New York, discussed in the preceding note, brings up the old question of engineer executives. Fortunately, we are class-conscious. We like to see one of our own number succeed, not merely for his own sake, but because of the luster he sheds on the profession. We believe, too, not without reason, that, given two executives of equal executive ability, the one with engineering training, if the position is one in charge of engineering work, will give the better account of himself. He will grasp the problems more quickly; his analytical ability, developed by his scientific training, will enable him more certainly to get at the essentials. But in the enthusiasm for our fellows and our profession we ought not to lose sight of the fact that executive work is distinct from technical work, and that success in it springs from qualities not necessarily developed in an engineering course. In fact, the qualities are but little developed in any college course. They depend more upon inherent qualities and on those developed outside of college—or at least outside the classroom—than upon book-training. The appointing officer, looking for a capable executive, must seek executive qualities first. If for a job much concerned with engineering he finds an executive who is also an engineer, so much the better—but his first responsibility is to find the executive. When we come to the appointment of an engineer as a member of a commission charged with an engineering project the situation is somewhat different. The transit construction commissioner at New York is a sole commissioner. As a rule, the qualifications needed on a board are judicial, rather than executive, and here the engineer will be invaluable, even though he does not possess executive ability. Of one thing though, there must be warning—of the temptation of an engineer-commissioner, or of an engineer-executive, to become the chief engineer as well. Confusion of judicial or purely executive work with technical detail is likely to lead to disaster.

Water-Supply and "Mobexpertocracy"

THE delay in obtaining a pure and adequate water-supply for Sacramento, Calif., has continued so long that, according to an editorial in the Sacramento *Union*, "gray-haired men are numerous in this city who remember the eternal discussion over a municipal water-supply that went on when they were boys. From that day to this not an advance has been made." The course of events shows how a city should not go about securing a water-supply. "Mobexpertocracy" was a word used editorially in *Engineering News-Record* of June 14, 1917, to denote the chief obstacle to progress. In the main the conditions deplored then still obtain.

The unusually comprehensive report covering well, river and mountain sources that was prepared three years ago by Messrs. Hyde, Wilhelm and Miller has not been acted upon. It seems rather to have added fuel to the fire of debate and discussion, despite the fact that there is no question about the capability or the unbiased judgment of the engineers who made the report. Since the first of this year a citizens' committee, unable to reach a conclusion, has called in C. E. Grunsky to add to the engineering reports on the subject. After a careful study Mr. Grunsky recommended the immediate construction of a filtration plant for purifying river water. The committee was wise enough to indorse the recommendation. An election has been called for June 26 to vote on a bond issue of $1,800,000 for carrying out the project recommended—a slight modification of the Hyde plan.

The use of wells as a source of supply, so strongly urged by one faction in the controversy, has not been recommended in either of the two reports mentioned because of the uncertainty of their yield, the litigation that would probably result from lowering the water table, and the question as to whether unsafe surface waters could be excluded. To avoid affecting the water table, wells would have to be near the Sacramento or American River, in which case a purification plant would be needed. A mountain supply, desirable though it may be, is not now feasible, it has been agreed, because of its high cost, but should the time come when it is feasible the proposed river filtration plant would become a standby or safety feature.

Engineering News-Record has no brief for any of the sources, but when experts agree, as they have in this case, and when exhaustive studies indicate some safe and sure means of relief, then it is not only unwise and unprogressive, but it is unlike our American spirit, to heed the lay "experts" who have nothing constructive but only pet theories to offer.

The issue seems to be clear. It will be interesting to see what the voters of Sacramento decide on June 26.

Ancient, War-Time and Present Water-Supply in Jerusalem

How General Allenby's Engineers Brought Water from Nile Across Desert—Ancient and New Permanent Water-Supplies of Jerusalem—Important Part Played by Caterpillar Tractors and Modern Pipe

By H. Y. Carson

Lately Captain and Sanitary Engineer, American Red Cross Commission; now With the Central Foundry Company, New York City

IN CARRYING the work of the American Red Cross into Palestine, following the reclamation of the Holy Land by the British troops, one of the first duties undertaken by the commission was that of surmounting the troubles occasioned by lack of proper housing and sanitation. Many of the troubles were due, primarily, to the difficulty of obtaining pure water.

IN THE VILLAGE OF RAMLEH

Carrying water jars on the head is still common in all Palestine.

The introduction of water into Palestine from the Nile is said to have been predicted thousands of years ago. It is no longer a prophet's dream, as the Nile water was brought to Palestine by General Allenby's able engineers when they fought successfully over the desert more than a year ago. American pipe and American equipment, joined with British ingenuity, accomplished the thing which had been foretold so many years ago. Caterpillar tractors hauled the pipe from Egypt over the sand of lower Palestine. The pipe and tools were the property of the Standard Oil Co., and were stored in Egypt just prior to the war. They were to have been used for piping oil from the recently developed oil fields there.

The water brought into Palestine at the rate of several million gallons per day was pumped from the so-called "sweet-water canal" near Kantara which has its source in the Nile. The British Royal Engineers erected at Kantara rapid sand filters very much like those on the Mississippi and Ohio Rivers. The plant at Kantara had a capacity of 5,000,000 to 10,000,000 gal. of water daily. Pumps sent by rail from Cairo impelled the purified Nile water through a 12-in. pipe across the Suez Canal and about 50 miles beyond the desert. At this point the water not actually used along the line was "picked up" from a newly constructed reservoir and delivered into a 10-in. pipe through which it was carried northward about 40 miles. Originally it was again pumped through an 8-in. pipe line some 50 miles to Gaza, but this force main has since been discontinued.

The pipes were laid directly in the sands of the desert and followed for the most part a parallel with the newly constructed railway. All of the piping, except for expansion joints, was covered with the soil or sand to a depth of 18 in. or more, thus protecting both the pipe and the water from the intense heat of the Palestinian sun. These waters of the Nile served only the lower portion of Palestine, the supply for such cities as Jerusalem, Gaza, Beersheba and Jericho being obtained from local sources, springs, wells, etc., some of which yield an abundance of pure water, others a scanty supply.

Under the surface, however, can be found plenty of water in all of the regions north of Beersheba. The geological formation and the meteorological conditions of Palestine account for the fact that very little water is retained on the surface of the ground. The surfaces are stony, the stone is mainly dolomite limestone (there is also some flint), so that the rain that comes during the winter soon percolates into fissures or crevices in the stone. Very little of the total rainfall runs directly to the sea; actually no rivers exist in Palestine except the Jordan, which, as is well known, is located in a huge "fault" far below the sea level.

On the western slopes of Palestine it will be a quite easy task to impound water, as the valleys or "wadys" are very steep, forming excellent reservoir sites for collecting the winter rains. The sites must be selected on flintstone formation, or else must be carefully treated so that the water will not escape by percolation into the crevices. One way of treating the slopes of the reservoirs would be to bare the stone surfaces and go over the crevices with a cement gun, thus stopping all the openings through which water can escape.

The climate of Palestine is subtropical, but it seldom rains during seven out of 12 months of the year. Although Palestine during its early history was a prosperous agricultural state, the Turks have simply stripped it of its trees, leaving the whole country a barren waste, as compared with its early reputation of the "Promised Land."

From the very earliest times, the inhabitants of Palestine have been hard pushed to obtain a supply of wholesome water, and possibly no other one physical attribute has so affected the political and religious history of Palestine. History relates how Hezekiah stopped up the outer entrance to the spring, "the Virgin's Font," in order to cut off the water-supply of those besieging Jerusalem, and brought it straight down to the south side of the city of David. The Bible further relates how "Hezekiah prospered in all his works."

Hezekiah carried out what is, to me, one of the most wonderful engineering tasks in history. The tunnel which he constructed stands almost unexplainable today.

HAIRPIN BEND ON JERUSALEM-RAMLEH ROAD

Illustrating difficulty of transporting materials in Palestine. Caterpillar tractor and two trailers in foreground. Beyond is steep slope of one of the "wadys" which afford possible reservoir sites.

Hezekiah's engineers conducted the water through the limestone hill from the east to the south side by a marvelously built conduit 1750 ft. long. An ancient Hebrew inscription on the west entrance of the tunnel has been translated to read: "The boring. And this was the manner of the boring . . . the pick each toward his fellow . . . boring the hewers struck each to meet his fellow, pick against pick, then went the waters from the issue to the pool for two hundred and a thousand [1200] cubits. . . ." The water flowing in this ancient aqueduct is still used from the Pool of Siloam, which is the terminal point of the tunnel. History seems to indicate that the water was conducted through the hill so that the intermittent spring on the east side of the village could be closed up and all of the water diverted into the Pool of Siloam.

One might easily go on describing the interesting part which water-supply has played in Palestine's history, but suffice it to say that today the land of Canaan needs the modern engineering skill of the West as it needs nothing else, for the development of its water-supply,

PIPE TRANSPORTATION AND LAYING IN PALESTINE

Tractors on Jerusalem-Hebron road hauling pipe for Jerusalem water-supply. Laying 6-inch pipe, in right foreground

its agriculture, its industry and its very place among the modern nations of the world.

Besides Hezekiah other noted men—Solomon, Pontius Pilate and Herod—attempted to get a supply of pure water into Jerusalem, but it remained for the British to do the job in little less than 70 working days. Water is now flowing by gravity through a 6-in. line from the springs at Wady-el-Arub, south of the city, at the rate of over 200,000 gal. per day. The total capacity of the line, which has a delivery head of 200 ft., is 300,000 gal. per day, but the springs have twice this capacity.

The springs at Arub are located about 16 miles south of Jerusalem, on the Bethlehem road beyond Bethlehem. It was probably Pontius Pilate who carried out with Roman engineers a wonderful piece of work there by developing the spring in the form of a gallery, collecting and conducting the water by aqueduct into a stone reservoir of 5,000,000-gal. capacity located about 2000 ft. from the main spring. Thence Pontius Pilate conducted the water to the center of Jerusalem, probably the temple site, by an aqueduct so marvelously constructed that it stands almost intact to this day. Moreover, the British Royal Engineers found little difficulty

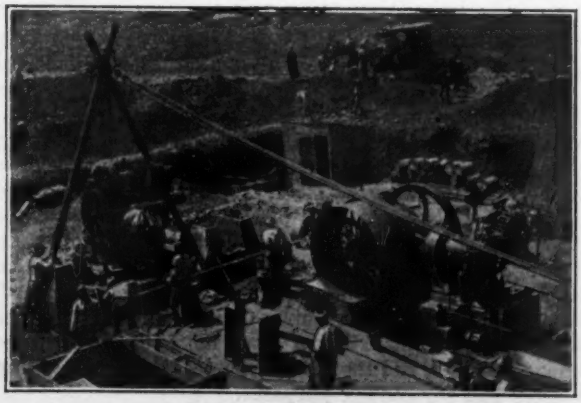
THE LOWER OF THE POOLS OF SOLOMON

The pools have a total impounding capacity of 80,000,000 gallons

in putting the spring and reservoir into service. The water is now elevated by a pump and a 66-hp. gasoline engine into a newly constructed reservoir on the top of a nearby hill. This new reservoir has a position over 500 ft. above the temple site in Jerusalem.

Practically every house has its own rainwater cistern, and it has been estimated that if all these cisterns in Jerusalem were full they would contain 360,000,000 gal. But most of them are usually found to be filthy. One recently inspected by the Sanitary Department had not been emptied for 19 years. Before a cistern is filled with pure water, however, the owner must obtain a certificate from the newly organized health department to prove that his reservoir has been rendered sanitary and mosquito-proof. He is then provided with enough water, through a temporary pipe line, to fill his cistern entirely, regardless of its size. The organized effort to supply pure, sparkling water to the 50,000 residents of Jerusalem has enabled them to have ten times more water than formerly. The picturesque water vendor, with his pigskin pack on his back, likewise the water fantanzies aboard the camel and the donkey, as well as the more charming picture of the native virgin carrying a sheriby (a thin, porous, earthenware jar) on her head, will soon be but a memory of Jerusalem. It is more to be hoped that the terrible water-borne diseases so common when Palestine was under Turkish rule will likewise pass quickly into the forgotten past.

The speed with which British sanitary engineers put



ERECTING PUMPING PLANT FOR JERUSALEM

At Berket-el-Arub, Kilo 23, Hebron road, Two 66-horsepower Hornby engines to lift 300,000 gallons of water under 500-foot head. Caterpillar tractor at work, in background.

into operation this new supply of clear spring water from the vale of Arub will ever stand in engineering annals. A preliminary investigation and survey of the ground was made Feb. 14, 1918, and a scheme was submitted four days later. Owing to the shortage in transport and unusually bad weather, it was not possible to begin work until Apr. 12. Even then the mud interfered with the huge tractors which hauled the many miles of pipe. The pump, which has a working capacity of 300,000 gal. per day under a head of 500 ft., the two 66-hp. gasoline engines brought from Cairo, and the pipe, were in shape for delivering water into Jerusalem by June 18—just 67 days after work commenced.

Jerusalem the Golden could be furnished with an ample supply of pure, sparkling water at a lower cost than it could be done in most American cities. It is possible to supply more than 20,000,000 gal. per day, and this will be sufficient in this country for a population of 1,000,000. In addition to the development of springs at Arub, a similar supply can be had at Wady Kelb, 12 miles distant. At Ain Fowar the winter rains can be impounded and the pools of Solomon can be put into service again with comparative ease.

Water-Waste Education by Bulletins

COINCIDENT with a comprehensive water-waste survey and intensive inspection methods in Buffalo is a campaign of education by bulletins issued periodically by the water department and circulated particularly among the less well informed consumers. The water-saving procedure was described in *Engineering News-Record* of Dec. 5, 1918, p. 1033. The material for the bulletins is taken largely from official records, which are put into easily understood language, with diagrammatic views of such things as the distribution by classes, coal consumed in pumping, water used and wasted, water consumption in other cities—showing Buffalo at the head of the list with its 339 gal. per capita.

One bulletin contains a succinct seven-paragraph description of the water-works system. Another contains instructions for repairing leaky faucets and closets of various types, and presents a table of waste for openings of various sizes. An explanation is made that coal saving during the war became much more than a question of thrift, since the bureau of water, which buys for pumping twice as much coal as either Cleveland or Detroit use, was notified by the Fuel Administration that its coal allotment had been cut from 65,000 tons to 50,000 tons per year. Waste prevention only could effect this saving. This statement was followed with results from eight test meters placed on services with antifreezing toilets, the estimated annual consumption averaging 2,300,000 gal. per year, ranging from 69,000 gal. (one toilet) to 9,580,000 gal. (two toilets). If billed at meter rates the owner of the latter service would have had to pay nearly $400 for his neglect. The regular rate is $1.50 per toilet, although a recent ordinance has raised it to $10 unless an inspection is made and an affidavit filed that the service has been kept in repair. Other points covered are the harm of sprinkling a lawn more than the three hours allotted, and the enormous waste caused by letting water run for cooling purposes.

One incentive to save that is set out is that plans for filters will be started only when the average daily consumption reaches 100,000,000 gal. It is now 124,000,000 gal. and was 163,000,000 gal. in 1917. Bills would be increased by filtration 62% if waste were not stopped, while the people can have filtered water for a 22% increase if the 322-gal. rate is reduced to 175 gal. As the rates decrease that fact is noted and the coöperation of the people is duly recognized.

Just how effective the bulletins are George C. Andrews, commissioner of water, by whom they are issued, is unable to say, but he is sure they give the consumer some understanding of a complicated public utility.

Niagara Falls to Be 100 Per Cent. Metered

FACED with the alternative of spending $500,000 for more filters and additional mains or of placing meters on every service, the Niagara Falls water department has recently decided to become 100% metered. The 3000 meters necessary are now being installed, and would all have been in place June 1 except for a plumbers' strike which threw the work upon the city's own force of two gangs. The installation will be completed this season, but Charles T. Shepard, superintendent, is of the opinion it will take three months before the majority of the consumers realize that they have leaks which must be stopped.

In a report dated Mar. 7, 1918, Mr. Shepard stated that the 16,000,000-gal. normal capacity of the filtration plant had been exceeded on cold winter days of 1917 and that the year's consumption was 26% more than that of 1916. A water-waste examination indicated that the 4000 flat-rate consumers were using 350 gal. per capita daily at a rate about seven times as much as the 3750 metered-service consumers. Manufacturing plants and large buildings consumed 32.9%; domestic services, metered, 6.6%; the city, 10.7%; flat-rate consumers, practically all domestic, plus all other unaccounted for consumption, 49.8 per cent.

Financially considered, 39.4% of the total metered pumpage paid 48.5% of the revenue obtained. This included 6.6% of the domestic metered pumpage, which paid 16.2% of the revenue. The flat-rate consumption and that used by the city produced 51.5% of the revenue. The flat-rate consumers are getting water for the lowest rate, 2.23c. per 1000 gal., which is not profitable, while the total water pumped was sold for 3.657c. The industries pay 3.44c., and metered customers 4.49 cents.

It is estimated that the installation will reduce the annual gross revenue more than $20,000, but the rate of return will be materially increased, and the cost of chemicals and power will be reduced by $4700 per year. The principal saving, however, will be in the 5,250,000 gal. of water, thus putting off for at least five years the time when the works must be enlarged.

Meters are installed by the city at nominal cost to the consumer, a flat charge of $10 being made for each ¾-in. service. All except about 100 meters will be placed inside the houses. Those in pits, which are being left to the last, will be set at the bottom of an 18-in. tile, 3 ft. long, bell end down, the service pipe being brought up from the usual 5- to 6-ft. depth. A cast-iron cover will be set on the top of the tile and a wooden disk placed on top of the meter, thus creating an air space to prevent freezing. A full-time meter superintendent will be employed, but the number of meter readers will not be increased, the city being redistricted so that the reading will be continuous throughout the year.

New Coal-Handling Plants for Philadelphia Water-Works

General and Detail Design of Three Systems Supplying a Total of 16 Boilers With a Total Boiler Capacity of 7400 Horsepower—Costs Reduced as Compared With Old Methods

By Harrison R. Cady
Bureau of Water, Philadelphia, Penn.

THE Philadelphia water-supply system was completed, in so far as new plants and major projects are concerned, in 1911, when the Queen Lane filtration plant was put in operation. The system now takes an average of 325,000,000 gal. daily from the Delaware and Schuylkill Rivers, filters it, and distributes it over an area of 129 square miles. While the filtration plants are all of comparatively recent construction, some of the pumping stations have been in operation for many years. Consequently, the increase in water consumption, together with deterioration and obsolescence of plant equipment and methods, has necessitated considerable work in the nature of reconstruction and the installation of new equipment. Much work of this kind was done in the four years previous to 1917, but in that year war conditions caused the abandonment of all new work which could be deferred. The more important undertakings include the installation of three complete coal-handling systems, 5400 hp. of boilers, mechanical stokers for 9400 hp. of boilers, 16 pumping units having an aggregate capacity of 195,000,000 gal. per day, and a complete high-tension generating and transmission system furnishing current for lighting and power at five small stations. This article will describe the new coal-handling systems. The general equipment of all five pumping plants is given in the accompanying table.

EQUIPMENT OF PUMPING STATIONS, PHILADELPHIA

Station	Boilers Number	Boilers Horsepower	Pumps Number	Pumps Horsepower
Belmont	6	3,000	6	6,300
Queen Lane	8	2,400	5	5,600
Shawmont	4	2,000	6	4,500
Torresdale	9	2,950	8	4,000
Lardners Point	14	7,000	13	16,000
Total	41	17,350	38	36,400

Belmont—The principal features of the coal-handling system at this station are shown in Fig. 1. About 115 tons of anthracite barley coal are used per day. All shipments are received by rail. Cars are dumped into the storage bins, beneath the tracks, where about 3000 tons can be stored without trimming. The bins have hopper-shaped bottoms leading to gates which feed the cross conveyor, a flight-type apparatus extending through a tunnel under the bins and discharging into a bucket conveyor. This conveyor carries the coal through a branch tunnel to the boiler house, elevates it and discharges it into the suspended steel bunker in front of the two boilers at the north end. From this bunker, having a capacity of 200 tons, the coal runs down into a 2000-lb. electrically operated weigh larry which distributes it to the stoker hoppers.

In this plant, as well as at the Queen Lane and Shawmont stations, the installation of the conveyor system was coincident with the change from hand-firing to mechanical stokers. Consequently, there is some difference in the point of delivery, a difference which would have worked to the disadvantage of the old system. In the comparative analysis of costs this difference will not be considered.

Under the old system, at Belmont coal was dumped into the same storage bins that are now used, and was trimmed to push cars which were moved on tracks, located substantially as shown in Fig. 1, to firing position in front of the boilers.

The cost of dumping cars and delivering coal to stoker hoppers under the new system is 24c. per long ton. This includes labor, interest, depreciation, maintenance, and power costs. Under the old system, the cost was 29c. per ton under pre-war labor prices, which would mean about 40c. per ton at present labor prices.

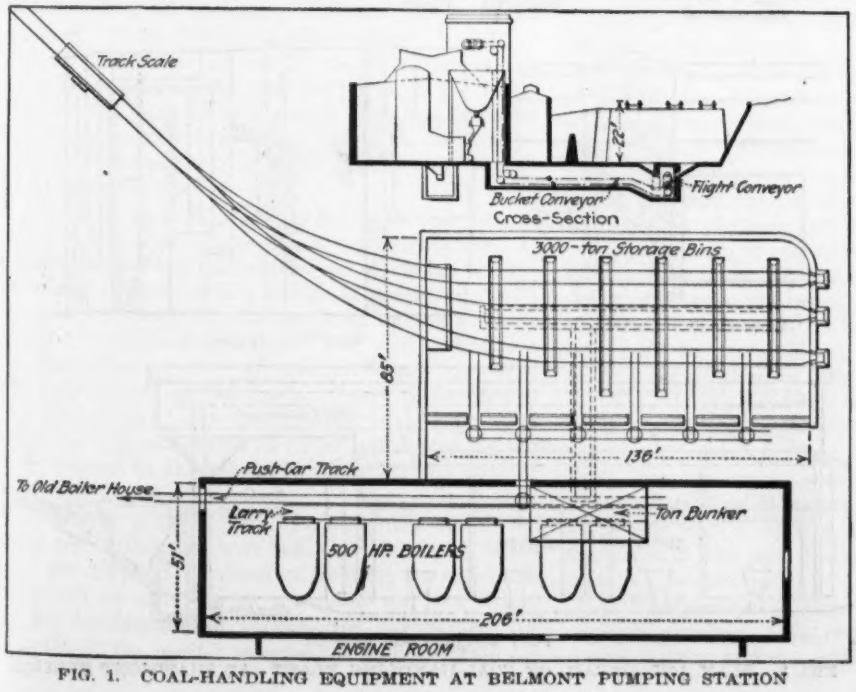


FIG. 1. COAL-HANDLING EQUIPMENT AT BELMONT PUMPING STATION

Queen Lane—The general location of this station, as related to streets and railroad line, is shown in the sketch plan forming a part of Fig. 2. The other portions of Fig. 2 show the principal features of the coal-handling apparatus and the storage bunker which constitute the new system. This station uses about 100 tons of anthracite barley coal per day, and receives all shipments by rail. The storage bunker, over which cars are placed for dumping, has a capacity of 3200 tons, without

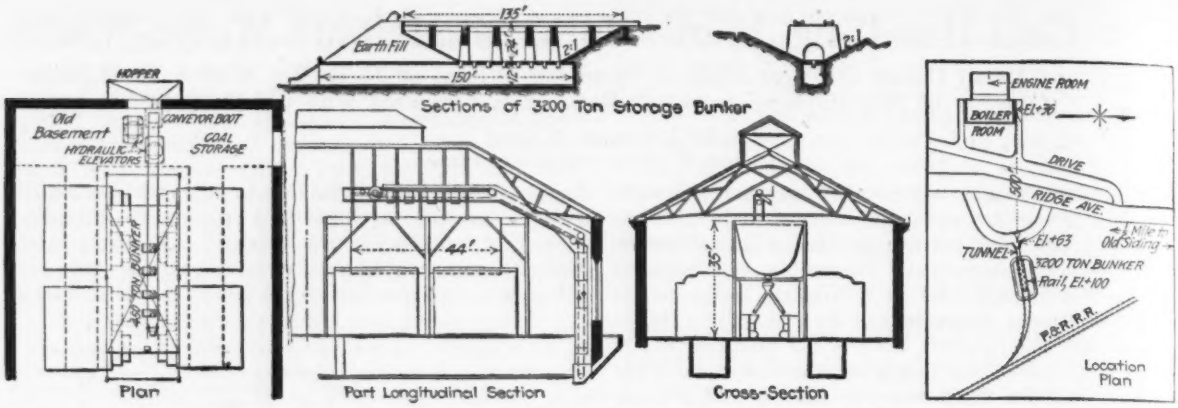


FIG. 2. GENERAL LAYOUT AND DETAILS OF QUEEN LANE STATION COAL-HANDLING PLANT

trimming. From gates at the bottom of this bunker the coal is discharged into motor trucks which haul it to the north end of the station, there dumping into a small hopper feeding a bucket conveyor. This conveyor, which has a capacity of 20 tons per hour, elevates the coal and distributes it along a suspended-type steel bunker of 450-ton capacity. Distribution to stoker hoppers is effected by means of a 1000-lb. hand-operated weigh larry. This larry is found uneconomical here and will be replaced by downspouts in the near future.

Under the old system the coal was hauled from a siding, more than one-half mile distant, where no dumping facilities were available, and it was necessary to shovel from the cars to wagons. The coal was dumped from wagons to bins in the basement at the north end of the boiler room and trimmed to push cars which were brought to the floor level by hydraulic elevators and then moved to firing position in front of the boilers.

At this station the cost of handling from the receiving hopper to stoker hoppers, with the new system, is 23c. per long ton, while the cost of unloading cars, storing and hauling is 24c. per ton, making a total cost of 47c. per ton. Under the old system the cost of handling was about 43c. per ton except when it became necessary to store coal in outside piles, when the cost of recovering was considerably increased. With the old apparatus and present labor prices, the cost per ton would be about 75 cents.

Shawmont — The general layout and details of this station system are shown by Fig. 3. About 70 tons of bituminous coal per day are used here, and all shipments are received by rail. The present coal-handling system was completed in 1916. Cars are dumped into a track hopper, with a capacity of 50 tons, which feeds a double-roll crusher. From the crusher a bucket elevator lifts the crushed coal to the conveyor gallery, where a flight-type conveyor carries it to the boiler room and distributes it in the bunker. This bunker is of the suspended-steel type and has a capacity of 275 tons. Distribution to stoker hoppers is accomplished by means of a 1½-ton motor-operated weigh larry. To provide for cases of delayed or irregular shipments a small storage pile is kept in the old storage shed; the coal from this is brought in push cars to the crusher.

Before the installation of the new system coal was received in the old storage shed which had a capacity of

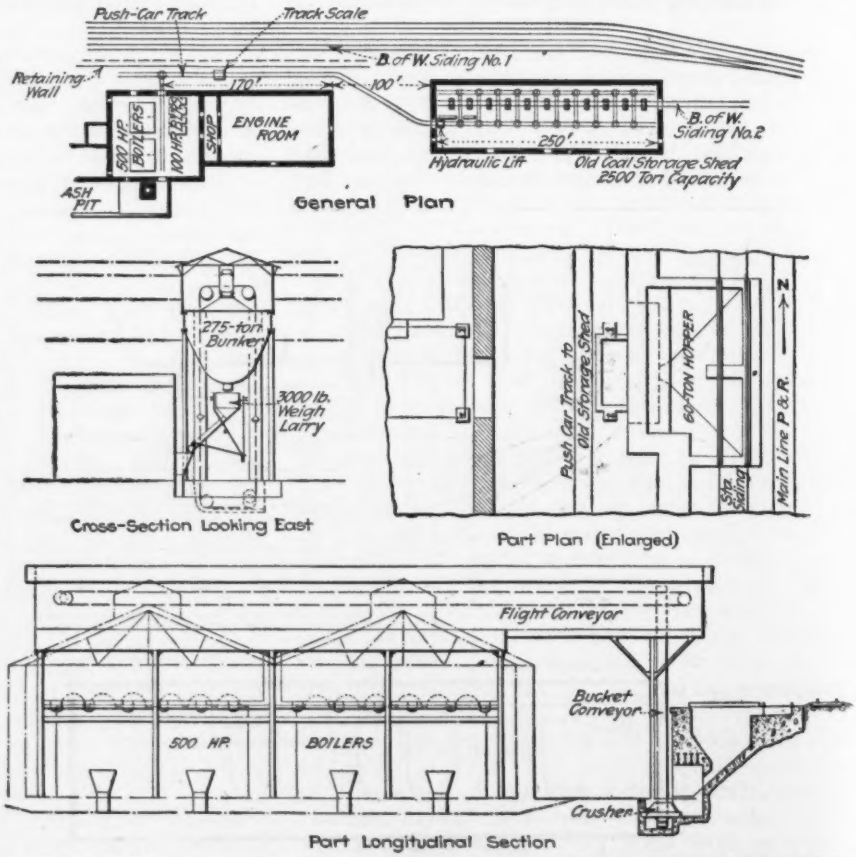


FIG. 3. PLAN AND DETAIL OF COAL-HANDLING PLANT AT SHAWMONT STATION

2500 tons, and was dumped from cars without trimming. The coal was then trimmed to push cars and moved by hand, on tracks shown in the general plan (part of Fig. 3), to the firing aisle in front of the boilers.

The total cost of handling the coal from cars to stoker hoppers and crushing is 24½c. per ton, not including the cost of dumping cars. Adding the latter cost, which amounts to about 8½c. per ton, we have a total cost of 33c. per ton. Under the old system it cost 34c. per ton to handle the coal from the cars to push cars in front of boilers, and increasing this cost to meet present labor prices would make the cost of handling coal now, with the old system, about 44½c. per ton.

To summarize the work of the three systems: In handling a total of 103,300 tons in the past year a saving of $19,150 was effected on the cost of operating the old systems. While this figure may be somewhat reduced in the future, due to lowering of wage scales, it will still remain high, for labor is by far the largest item of cost; and to offset any such reduction there will be certain improvements in operation and apparatus. In addition to the saving in handling costs, to the Queen Lane station has been afforded an easily recoverable reserve storage of 3200 tons, and the Shawmont station has crushing apparatus. The total cost of the three systems was about $54,000, of which the cost of the Queen Lane station's storage and hauling equipment amounted to about $27,000.

Some Engineering Problems of City Planning

Abstracts of papers before the National Conference on City Planning, held at Niagara Falls and Buffalo last week—Regional planning, industrial cities, the steam railroad and the city plan, the common sense of civic centers

Regional and Town Planning

By Thomas Adams

Housing and Town-Planning Adviser of the Canadian Government, Ottawa

TO PLAN our cities and towns properly we must investigate and analyze many problems which have a bearing on life and growth within and surrounding them. Recent tendencies in industrial decentralization have shown the importance of one of the modern aspects of town planning, namely, the direction and control of the growth taking place within the rural and semi-rural districts where new industries are being established. The artificial boundaries of cities are becoming more and more meaningless. The real controlling factors which determine and encourage industrial growth are physical and natural to a greater extent than they are administrative and artificial.

One of the difficulties in dealing with this subject is that we have not yet adopted a clear and unambiguous terminology. Some definitions are in order:

1. *The regional survey* has to do with the investigation and mapping of the existing physical, industrial and residential features of a region that has interests and problems in common, which needs comprehensive and coördinated treatment without regard to arbitrary administrative boundaries.

2. *The regional plan* is concerned with the general planning of the area included in a regional survey. It is a skeleton and tentative plan of a region within which there is comprised a series of municipal units in juxtaposition with one another, and having overlapping and interrelated problems. The width, direction and classification of our main and secondary highways should be governed by the needs of such a region and not by the needs of one municipality within it. This principle is fully recognized in Ontario highway legislation, in regard to the principle on which the cost of construction is apportioned.

The planning of our system of communications in the regional plan should also have regard to the classification of land for different purposes of industry or residence. Land should be classified in a general way for industries, for residences and perhaps for agriculture, for park areas or for special reserves, or as unsuitable for building purposes. We would also consider within the region how far it is desirable to prescribe a code of housing and town-planning regulations to deal with building conditions that need to be dealt with in common over large areas of different character. Sewerage and water-supply may have to be dealt with in large regions to obtain efficient and economical schemes, in cases where it is not practical to get an efficient system of either in separate units of administration. These and other problems that can be dealt with in a preliminary and general way need regional rather than municipal treatments.

3. *The town plan* is the definite plan, accompanying a definite piece of legislation, for fixing within the city or the country areas, first, those parts of a regional plan which are locally approved, and, second, the civic design and regulation dealing more intimately and precisely with the problems connected with the growth of the town, its means of communication, its industrial development, its residential areas, its character and density of building, etc.

We thus have three distinct processes, connected with one another and logically leading up to one another, which are the regional survey, the regional plan and the civic plan. It is unnecessary for me to argue with town planners how hopeless the task is to attempt to prepare a plan without having obtained accurate data regarding existing physical and industrial conditions.

We hear much of reconstruction. One of our greatest needs is to know what and how to reconstruct. In parts of Europe the work of reconstruction is simple and clear. It is a matter of rebuilding what has been destroyed by war. Here, reconstruction has to deal with involved human and economic problems, with transition from disorder to order, with remedies for traffic confusion, and with bad housing and wastefulness of resources. As an English writer recently said, "the monument which this war demands is the reconstruction of the material fabric of civilized life, its reconstruction upon a survey and a plan," and, as Carlyle said long ago, the most effectual of all work of man is wise planning.

It is impossible in this brief paper to analyze the complex problems that need consideration in the regional survey and the regional plan. All that I can

attempt to do is to present some of the reasons why they are necessary and to indicate some of the problems with which they have to deal. I claim that the nature of modern growth of communities, of the relation which exists between different elements in our community life, and the changes which are ever taking place in methods and conditions, impose upon us the obligation to deal with the regulation of growth on elastic principles over wide areas, and at greater expense of time and money than we have hitherto given to it. We must not only prepare our schemes by gradual steps, but prepare them in such a way that gradual fulfilment will be obtained. While our ultimate objective must be clear in our minds, we must be content to work toward it by successive steps instead of jumping to the concluding stages without adequate measures of preparation.

The Niagara district seems to me to be one which needs the making of a regional survey and a regional plan as a preliminary to a series of civic plans for its city, town and county areas. Neither Buffalo nor the Tonawandas nor Niagara Falls is a strategic conter. They are parts of a strategic center of 1000 square miles in extent on both sides of the Niagara River. The problems of this region are international, and give us proof that the power of natural conditions is so great that even the boundaries of nations do not form intelligent and appropriate boundaries to regional and town-planning schemes. Indeed, may we not hope that in the process of planning them we will help to knit these two nations, their industries and people, closer together; and also that the bridge which we propose to erect as a symbol of peace will be more than that, will be a symbol of coöperation and mutual respect? Personally, I should like to see something more than a physical bond; such a bond as could be provided by a regional planning commission representative of the State of New York and the Province of Ontario, to deal with the planning problems of the Niagara district. That need not be an idle dream, any more than the creation of an international waterways commission.

Planning Problems of Industrial Cities

By John Nolen
City Planner, Cambridge, Mass.

THE modern city is the industrial city. Most of the planning problems and most of the evils of the modern city are due to manufacturing.

What do we mean by an industrial city? Not a city that is exclusively industrial—few cities are that—but a city that is primarily industrial, a city whose existence and growth depend mainly upon manufacturing. In this sense Bridgeport, Akron, Niagara Falls and many other American cities which are now beginning to grapple seriously with their planning problems are industrial cities.

What are the planning problems of industrial cities? There are two broad divisions, not mutually exclusive by any means, but they can with advantage be considered separately: Those that have to do directly with the economy or efficiency of manufacturing; those that have to do directly with the contentment and welfare of the wage earner, and indirectly (some would say directly) with the economy and efficiency of manufacturing.

The requirements of manufacturing cities are level land, cheap land, few streets (large blocks), room for extension; railroad or water facilities; proper zones; main thoroughfares for hauling (no grade crossings); proximity of factory sites to good housing; trolley or motor-bus transportation for employees if homes are not within walking distance; location of factories with due consideration to prevailing winds; public utilities. Equally important are homes for workmen. Consideration must be given to the house itself; the garden; the protected residential zone; local streets; recreation areas; schools and part-time schools; churches, and main streets to the factory, the low-cost housing and the downtown districts. Consideration must also be given to costs in relation to wages—cost of the home, of living and taxes.

Among the city-planning features of industrial cities may be mentioned especially main thoroughfares, problems in regard to which are connections for goods (factory to freight stations, water terminals, etc.), grade, width, alignment, and freedom from railroad crossings.

What is the difference in the planning of an industrial city and other cities? It is mainly a difference of emphasis of those things which have to do with economy and efficiency in manufacturing, and with the contentment and stability of wage earners. Some of the economic effects of planning upon costs of production are: Proximity to raw material; the elimination of unnecessary cost of hauling and shipping, reduction in labor turnover; and decent living and working conditions both in homes and in factories.

A study of industrial cities discloses the fact that the power, growth and progress of a city are limited only by the initiative of its leaders and the united civic interest of its people.

The challenge to the members of the National Conference on City Planning is, "Do you know of a single industrial city that can claim a reasonable mastery of its planning problems, if tested by the topics here enumerated?" If such cities cannot be named, what are the reasons?

City Planning Handicaps at Niagara Falls

The City of Niagara Falls is at present greatly handicapped in its efforts to obtain an orderly and attractive development by the unfavorable existing conditions, which interfere seriously with its success as a resort, its efficiency as an industrial city, the stability of its property values, and with the growth and increase in wealth of its population.

The removal of these handicaps involves the relocation of the railroad rights-of-way and of the union station, also the elimination of grade crossings (all of which are definitely contemplated), the planning and construction of an appropriate and adequate major street system, the selection and development of a system of parks and parkways, the acquisition of sites suitable for public buildings, schools, etc., and the adoption of an ordinance providing for the separation of city areas for various city needs.

In connection with the rail and water transportation problem, new locations are proposed for the railroad right-of-way, the elimination of grade crossings, the site for a new union station, other railroad development, and the barge-canal terminal and pleasure-boat landing.

The consideration of main thoroughfares includes the selection of existing streets best located for traffic, the extension of existing streets, the locations for new streets, and widenings.

The Steam Railroad in Its Relation to the City Plan

By Edwin J. Fort
City Manager, Niagara Falls, N. Y.

TO A very great extent the presence of the railroad determines the character of improvements in its immediate neighborhood, the location of manufacturing industries, development by certain classes of business enterprises, or the poorest class of residences or tenements. The slums and undesirable resorts and the nuisance-producing enterprises are usually not far from the railroad.

When the topographical features of the surrounding territory are such that expansion in every direction is unrestricted, the evils of undesirable railroad location are not so serious, because the city can grow away from them and business can adjust itself, but when, as is the case in Niagara Falls, the site is inclosed upon two sides by an international boundary line and a stream, which so far as the growth of the city is concerned, are impassable, it is most essential to orderly growth and development that the problem of railroad location be given the most careful study and be so worked out that all industries shall be adequately served, that shipping facilities shall be convenient and stations shall be located with due regard for the comparatively large passenger traffic.

We have here [Niagara Falls] no more serious or difficult problem to deal with, in carrying out an acceptable city plan, than that of the treatment of railroads.

Within its comparatively limited area of less than nine square miles, Niagara Falls is crossed from north to south by three surface-railroad lines and from east to west by two such lines. It also has within its corporate limits four separate and distinct extensive railroad yards. The Erie R.R. cuts through what might have been a most desirable residence district, and has its yard at the highest point, almost exactly at the place where the new civic center of the greater municipality is designed to be placed. Obviously, the ideal in the way of a city plan cannot be attained unless some changes are made in those conditions.

There are several alternatives. Lines may be relocated so as entirely to eliminate some of the most objectionable ones. They may be elevated or depressed so as to allow streets to cross at grade, or they may all be allowed to remain as they are, depressing or elevating street crossings where, from time to time, it becomes necessary to do so.

Regardless of what the final plan may be, great relief to every one concerned and considerable advantages to the railroads themselves would come from the electrification of all lines within the limits of the cities located along the Niagara frontier. The abundance of cheap electrical power and the rapid increase in business and population which is taking place should make such a change practicable in the near future.

Such changes as have already been made have consisted in elevating street crossings entirely above the tracks or depressing them below them in such a way as not to disturb the tracks either as to line or grade. These changes add nothing to the embellishment of the city. They are not convenient for street traffic and they are expensive. An indefinite continuation of this method of grade-crossing elimination would result in much haphazard building and in waste of public funds.

If the city is to continue to grow through the development of its enormous resources in power and a corresponding increase in manufacturing industry, the time cannot be far distant when some of the handicaps caused by indiscriminate railroad location must be removed and the districts blighted by them reclaimed.

The Common Sense of Civic Centers

By Nelson P. Lewis
Chief Engineer, Board of Estimate and Apportionment, New York City.

AMBITION to create civic centers has become quite general and is laudable. Many projects of this kind have been proposed, some prompted by a desire for the spectacular; others by the hope of realizing some ill defined ideal; some, perhaps, by the prospect of personal gain; and still others through an appreciation of the value of order and economy in public business.

In a study of the civic-center problem the following fundamental principles should control: (1) The centralization of all city business in one locality, while it may result in economy and convenience in the case of a small city, may prove costly and inconvenient in a large city; (2) civic centers should be planned so that only related public business and activities need be concentrated in them, subordinate or secondary centers being established when overcentralization becomes apparent; (3) secondary centers should be so located as to be easily accessible through direct traffic routes from the principal center and from one another, and readily found by those desiring to reach them; (4) the possible need of principal and secondary centers should be kept in mind when developing the plan of any city and its successive additions, so that a rearrangement of the streets about or leading from them may not be necessary; (5) it should be assumed that the buildings comprising the civic group or groups will be worth seeing, and the chief buildings should, therefore, be on the axis of one or more of the streets leading to them; (6) some competent and continuing authority should be required to approve plans for all civic centers and designs for all public buildings or other structures located in or about them, and such plans, once approved, should not be changed without the concurrence and approval of the same authority.

American Engineer to Build Water-Works at Lima, Peru

W. W. Handley, American consul at Lima, Peru, reports that a new water-supply is being designed for the City of Lima by F. W. Spalding, an American engineer now resident in Miraflores, Peru. It is stated the work includes the construction of infiltration galleries for the collection of the water, the necessary aqueducts and distribution reservoirs, and an entirely new cast-iron pipe distribution system, at a total cost of approximately $2,000,000. Work has already been started on the construction of the infiltration galleries and on the reinforced-concrete pressure main. Plans and estimates have also been prepared for a new sewer system and sewage-disposal plant to cost approximately $1,500,000, and a garbage-disposal plant to cost about $150,000. Mr. Spalding was especially engaged by the municipal gov- of Lima to go there and make a report on the various engineering undertakings contemplated.

Highway Design and Construction Papers Read Before Canadian Road Congress

While there were some papers dealing with after-war and the more general roadbuilding conditions, the great majority of the subjects on the program of the sixth Canadian Good Roads Congress dealt with practical problems in the design, construction and maintenance of the various type of country and city highways. The following are abstracts of three of the papers read at the meeting—EDITOR.

Design and Construction of Hot-Mix Asphalt Pavements

BY FRANCIS P. SMITH
Dow & Smith, Consulting Engineers, New York City

HOT-MIX asphaltic pavements, which are distinguished from those of the so-called penetration type by having both the mineral aggregate and the bituminous cement heated and mixed hot, differ from one another chiefly in size and kind of mineral aggregate used, the bituminous cement or binder being substantially the same in each case. The function of the mineral aggregate is to give the requisite amount of stability, while the bituminous cement binds the aggregate and gives pliability to the pavement. It is generally conceded that the ideal surface for mixed traffic is one which is slightly malleable (approaching sheet lead in this respect) as this will minimize wear and noise. This malleability precludes extreme rigidity, hence the malleable pavement will be low in bridging strength and will require a rigid foundation. The ideal pavement, therefore, would appear to be one in which the foundations and wearing surface were separate and composed of materials differing very widely in their properties. All bituminous pavements are, to a certain extent, malleable and yielding; thus the wear of the mineral particles are minimized, and the pavements are made more acceptable for horse-drawn traffic. To obtain the best results, great care should be taken in mixing the surfacing, to get the proper pliability.

FOUNDATIONS

Several different types of foundations have been successfully employed, such as old macadam or telford; broken stone rolled dry or cemented together with some form of bituminous cement; old cobblestones, Belgian blocks or granite pavements; old brick or asphalt-block pavements; bituminous concrete, and natural and portland-cement concrete.

In all of these, stability is the important characteristic. If the foundation is unstable it will sink after the pavement has been put down, and thus will be formed a depression in which water will collect and eventually destroy the pavement. Wheels of vehicles passing over such depressions will drop into them, and the force of the blow will further exaggerate the depression by forcing up a portion of the surfacing. Vibrations in the springs will also be set up, which will cause successive blows to be dealt to the pavement until the springs return to normal. This action, particularly in commercial vehicles, will sooner or later form waves which will be unpleasant to ride over, and which will finally require the resurfacing of the street or road.

The character of the foundation required will depend upon the traffic, the climate, the character of the subsoil, and drainage conditions. The heavier the traffic the stronger must be the foundation. Where traffic is light, the first two types of foundation, named above, may be used. In the opinion of the speaker, telford is preferable to macadam, on account of the larger stones composing its base, which give a partial slab effect. A well drained subgrade is of first importance with this type. In resurfacing, the old macadam surface should be disturbed no more than is necessary to obtain a bond, and the new surface should be reconstructed exactly as if a new macadam road is to be built. Many so-called macadam roads are little more than dirt roads covered with stone and have never been properly drained. In all cases a complete investigation of the history of the road by taking borings and inspections, particularly in the spring, should be made, and provision should be made for draining and rebuilding.

STABILITY IMPORTANT IN BLOCK PAVEMENTS

Old pavements of brick, granite, etc., should not be used as a base if it is first necessary to reset them. In their original condition they are satisfactory, if the traffic is not too heavy. Relaid blocks, until bedded by traffic, are not rigid, and have a tendency to rock, and asphalt pavements laid on such foundations in New York City have rapidly disintegrated wherever they were exposed to heavy traffic.

Bituminous concrete is sometimes employed as a foundation. One of the best types is made of crusher-run stone, from 2-in. down to dust, so graded and mixed with sufficient sand as to make a fairly dense and rigid mixture carrying about 6% of asphalt cement. When it is kept clean after laying and the wearing surface is laid upon it at once, no binder course is necessary. It has less bridging strength than portland-cement concrete, should only be laid on firm, well drained subgrades, and is not suitable for very heavy traffic. It is usually laid from 4 to 6 in. thick. This type has a number of advantages over portland-cement concrete: It is subject only very slightly to expansion and contraction cracks; it binds more strongly with the surfacing, and is also water-repellent, so that underlying moisture will not be drawn up through its pores and attack the bottom of the wearing surface—a frequent cause of disintegration of bituminous pavements laid on cement-concrete foundations.

Portland-cement concrete foundations vary, according to conditions, from 4 to 9 in. in depth, and before they are laid the subsoil should be thoroughly drained and compacted. On certain very heavy clay coils, such as are found in the Northwestern sections of the United States and Canada, which crack and heave very badly in winter, transverse trenches should be dug every 25 or 30 ft. and filled with coarse broken stone. These should be connected and drained to longitudinal trenches at the side of the street, which in turn drain into catch basins. Sand or gravel should then be spread upon the subgrade and compacted to a depth of from 3 to 4 in., and the concrete should be laid upon this instead of the natural soil. Under rapid temperature changes cement-concrete foundations are liable to crack. When the cracks are large the overlying bituminous wearing

surface frequently cracks in or near the same place. Rich, dense concretes are more liable to crack than leaner mixtures, and the speaker advocates a monolithic structure composed of a rather lean mixture, not richer than 1:3:5. Transverse expansion joints in the concrete base to overcome cracking are not altogether satisfactory, as cracks in the surfacing are liable to occur directly over them.

Preparation and Laying of the Wearing Surface

Upon the foundation is placed a wearing surface composed of mineral aggregate and bituminous binder mixed hot. The mineral aggregate constitutes from 80 to 90% of the pavement, and takes practically all the wear resulting from traffic. It must, therefore, be selected with great care. It must be hard enough to carry the traffic; it must have clean grains of particles to insure the adherence of the bitumen to them, and these grains or particles must be graded from coarse to fine, so as to make a pavement of maximum density and with sufficient inherent stability to resist displacement under the shoving action of traffic. Earth, sand, gravel, broken stone or slag, and finely ground limestone or portland cement or combinations of them, are the materials used in hot-mix pavements.

With all these aggregates (with the exception of the earth), the particles should be prefectly clean and free from clay. Material of a flinty nature should be avoided, as the bitumen will not adhere to it. Broken stone is superior to gravel, which should only be used for light traffic and should preferably be crushed. Dense, hard limestone will carry medium and light traffic satisfactorily. Where the traffic, even though comparatively light in volume, is composed of heavy, iron-tired vehicles, a dense hard trap is required. Where slag is used, a dense basic slag is to be preferred. It should be stable when exposed to the weather, and should show no tendency to slack or disintegrate. It is only suitable for light traffic, and should preferably be coated with a very fluid bitumen.

For filler, portland cement is to be preferred for heavy traffic, while ground limestone is preferred by the speaker for light traffic, as it does not have so markedly drying an effect. Whichever is used, it should be ground so that at least 65% of it will pass a 200-mesh sieve. Pulverized clay has also been used with excellent results, but is difficult to handle.

Great care should be taken in mixing the bituminous cement (which should conform to the best standard specifications) with the aggregate. A uniformly good mixture cannot be turned out by an imperfect plant. The best type of plant is that in which the sand or stone, or both, are heated in revolving driers, and fed by means of elevators into a storage bin. Bituminous sand is heated in properly designed melting kettles. The ingredients should be measured or weighed (preferably the latter) and mixed in a twin-shaft mixer of the pug-mill type, which should have a speed of from 65 to 80 r.p.m. For ordinary work each batch should receive a full minute of mixing. It is important to insure a thorough coating of the surface of all particles with a firmly adherent film of bituminous cement. Great care must always be taken not to overheat either the mineral aggregate or the bituminous cement, as this will injure and harden the latter.

In plants used for constructing pavements made of pulverized earth, the grains after heating are subjected to pulverization, which breaks up any clay balls which may have formed and cleans the sand grains. Owing to the large percentage of water which clay earths are liable to contain, these plants must have a much larger drier than ordinary sheet-asphalt plants. Extreme fineness of the mineral matter necessitates a completely inclosed mixer and measuring box and special dust-collecting devices.

Of the raw materials which have been mentioned, four distinct types of hot-mix pavements are made. They are as follows: Sheet asphalt, Topeka pavement, bituminous-concrete pavement, and pulverized-earth pavements, commonly known as National pavement. The table shows a typical analysis of the types:

TYPICAL ANALYSIS OF VARIOUS TYPES OF HOT-MIX PAVEMENTS

	Sheet Asphalt—Light Traffic Per Cent.	Sheet Asphalt—Heavy Traffic Per Cent.	Topeka Mixture Per Cent.	Bituminous Concrete Per Cent.	Pulverized Earth Pavement Per Cent.
Bitumen	11.0	10.5	8.5	7.0	17.5
Aggregate:					
Passing 200 mesh	14.0	10.5	8.5	5.0	55.5
Passing 100 mesh	14.0	10.0	6.0	4.0	12.0
Passing 80 mesh	13.0	10.0	6.0	2.0	6.0
Passing 50 mesh	19.0	14.0	6.0	5.0	5.0
Passing 40 mesh	11.0	14.0	10.0	4.0	3.0
Passing 30 mesh	10.0	13.0	10.0	4.0	1.0
Passing 20 mesh	5.0	10.0	9.0	3.0	....
Passing 10 mesh	3.0	8.0	6.0	5.0	....
Passing 8 mesh	....	....	6.0	3.0	....
Passing 4 mesh	....	....	14.0	7.0	....
Passing 2 mesh	....	....	10.0	20.0	....
Passing ½-inch mesh	....	....	....	14.0	....
Passing 1-inch mesh	....	....	....	12.0	....
Passing 1½-inch mesh	....	....	....	5.0	....
	100.0	100.0	100.0	100.0	100.0

Sheet asphalt will sustain a very heavy traffic. This statement applies more especially to a traffic largely composed of quick-moving, light, medium-loaded vehicles, such, for instance, as prevails on Fifth Ave., New York City. It is not the most suitable type of pavement for very dense, slow-moving, heavily loaded, iron-tired traffic. Nor will it give satisfaction where there is practically a total absence of traffic, as it then is liable to develop cracks, apparently requiring the kneading action of traffic to equalize the stresses set up by contraction and expansion and to keep it in proper condition. On account of its smoothness, where the traffic is heavy, a 3 to 4% grade is usually considered as the limit for this type, although traffic grades as high as 9 to 12% have been used.

Generally speaking, the heavier the traffic, especially iron-tired traffic, the finer should be the mineral aggregate used. This is because the coarse particles are more liable to fracture than the smaller particles. Where fracture takes place to any considerable extent, rapid deterioration of the pavement will ensue, as the bituminous cement ordinarily used is not sufficiently fluid at atmospheric temperature to rebond and recoat the fractured particles. These will quickly be pulverized and washed out, leaving depressions where water will accumulate and eventually rot the pavement. Where traffic is largely or wholly composed of rubber-tired vehicles, a greater proportion of coarse particles is permissible and is desirable, as it gives greater stability.

Standard sheet-asphalt construction at the present day is 1½ in. of binder and 1½ in. of wearing surface. The binder should be of the "close" type; that is, it should contain approximately 20% of material passing an 8-mesh sieve, and approximately 15% each of ¼-in. and ½-in. stone. A "close" binder properly made and laid will be superior in many respects to the mixtures

that have been laid on a large number of country highways, and will carry a fair amount of traffic for a considerable time without suffering any serious damage. A poor binder will cause serious damage to the pavement. In all hot-mix asphaltic pavements great care should be taken to compress the binder thoroughly, if one is used, with a steam roller, before laying the wearing surface, and, in turn, the wearing surface should be thoroughly compressed.

When the surface mixture is delivered upon the street it should be of such a temperature that it can be properly compressed and should be evenly spread by means of hot iron rakes. In many cases the loads of hot surface-mixture are dumped directly upon the spot where they are to be spread. This is a bad practice, as the men trample upon it while shoveling and raking it, and rakes do not thoroughly loosen up this trampled material when passing over and through it. Although the mixture is raked to a uniform surface of apparently even thickness before it is rolled, those portions which have been trampled on before and during raking are really covered with a greater quantity of surface mixture than those which have not been trampled on. When these spots are rolled there will be a slight unevenness in the finished surface.

Extreme care should be taken to insure a proper union between the work laid on successive days. The first load laid in the morning should be a little hotter than normal, so that the hot mixture may soften the cold edge of the joint. The practice of painting the edge with hot asphaltic cement is not to be recommended, as there is danger of making that portion of the pavement too rich in bitumen and softer.

Topeka Pavement Better with Binder Course

Topeka-mixture pavements are laid from 2 to 3 in. thick, and are frequently placed directly on the foundation. Much better results are obtained by using a binder course 1½ in. thick, with a 1½- or 2-in. wearing surface. This greatly reduces the tendency of finished pavements to shove. With a well graded mixture a squeegee coat is unnecessary, although it is frequently employed. Great care should be taken in mixing these surfacings, and the amount of asphalt must be watched much more closely than is necessary with sheet-asphalt mixtures. One-half of 1% above or below normal is about the permissible variation.

Bituminous-concrete pavements, as previously noted, have a mineral aggregate consisting wholly or largely of stones of varying sizes from 1½ in. down. Some of them are made of crusher-run stone, and some of them (bitulithic, etc.) are made of carefully graded aggregate. Where the aggregates are graded, it is customary to separate the particles of different sizes in from three to five bins, and weigh out definite amounts from each bin for every batch. From 2 to 3 in. of surface mixtures are usually laid directly on the foundation. Pavements of this type will not carry as heavy an iron-tired traffic as will sheet asphalt or Topeka. Both Topeka and bituminous-concrete pavements can be laid upon somewhat steeper grades than sheet asphalt.

Pulverized-earth pavements are usually laid without any binder course, and from 1½ to 2½ in. in thickness. They are very rich in bitumen (15 to 20%), but are extremely stable, and so malleable that at temperatures of 60 to 75° F., a piece may be cut out of them and hammered back with a hammer, and a perfect cold weld obtained. Their stability is due to the extreme fineness and absorbent properties of the mineral aggregate. On account of this fineness it is impossible to wear away the surface by any fracturing or grinding of the individual particles, as they have been reduced to practically their ultimate state of fineness before they are incorporated in the pavement.

The clayey material of which the pavements are composed has a much greater affinity for bitumen than any other known paving material, which still further adds to their permanence. With the exceptions noted under the discussion of plants, their manufacture and laying are very similar to those of sheet asphalt. The cost is somewhat higher than sheet asphalt, owing to the large amount of water frequently obtained in the mineral aggregate which must be dried out, and the high percentage of bitumen used in them. They are capable of carrying the heaviest kind of traffic, and when properly constructed mark less in summer than do sheet-asphalt pavements and are much less susceptible to shoving and displacement. They are equally suitable for very light traffic. The bituminous cement used is about 90 penetration at 77° F., which is much softer than is used in other types of mixed pavement. For this reason they do not become hard, and crack when not subjected to traffic for a considerable time.

Testing Aggregates for Concrete Roads

By H. Eltinge Breed
Consulting Engineer, New York City

GOOD concrete depends on the quality of the materials—cleanness, hardness, toughness, gradation and proportioning—combined with placing and curing. Methods of testing concrete for road use, chief among which are those for abrasion and impact, are important. Impact tests are by far the most valuable in determining wear-resisting value. Results obtained from a large number of tests made by the New York State Highway Department, with a special machine, seems to justify several conclusions, as follows: (1) Crushed-stone concrete resists impact better than gravel concrete; (2) large-sized materials are more durable than those of small size; (3) toughness is a very important factor in aggregate; (4) the fine and coarse aggregate must both be good, and (5) coarse-grained sand mortar resists impact better than mortar made from fine sand.

First in importance are the materials used; they determine the quality of the pavement. The fine aggregate should be tested for: (1) organic impurities, by the colorimetric test; (2) gradation (sieve analysis); (3) mortar strength, by testing briquettes; (4) volume of silt or loam by measurement. These are all field tests, except the third, and are very valuable.

The coarse aggregate cannot be tested in the field. Field determination of these materials can be made only for voids. Visual inspection should, of course, detect soft material and dirty aggregates. Such inspection should be made constantly, to know that the material is running uniform and of quality equal to the original sample.

For laboratory test of coarse aggregates, the most valuable is the Deval abrasion test. It is in general use and has been standardized. How accurate it is in determining the suitability of coarse aggregate for con-

crete remains to be seen. It is certain, however, that this test indicates the difference between poor and good stone; and, taken in conjunction with the impact test, described later, it is the best means we yet have of determining the suitability of stone for concrete roads.

Tests for pebbles (called gravel by some) with the Deval machine have been unsatisfactory, because certain pebbles much inferior in service to trap and syenite rock show less loss when tested than do these standard materials. In 1915 the New York State Highway Department laboratory modified the Deval stone-abrasion machine by substituting a slotted cylinder for the closed cylinder. The slots allow the fines to escape, so there is no protective cushion of dust to keep the pebbles from wear. For four years we found that this machine has given slag and pebbles a truer rating in accordance with the service test, though often at variance with the showing of the standard cylinder.

After testing the aggregates, we made tests of the resulting concrete, for two purposes: (1) To determine its wear; (2) to determine its strength.

By far the most valuable test to determine the wear-resisting values is a machine which generates impact stresses, closely paralleling those imposed by traffic. This machine was described in *Engineering News-Record*, of May 2, 1918, p. 861, by H. S. Mattimore, engineer in charge of physical testing, New York State Commission of Highways. In general, the machine consists of an arm which is raised by a cam and falls freely, striking a 6-in. concrete cube or cylinder upon a table which is revolved by a dog attachment. At the head of the arm are placed nine hitting points, armored with nonslip horse calks, each point and its shaft being held in place by a spring giving a play of ½ in. to compensate for any irregularity or unequal wear. The effective weight of the head is 29 lb., and the blows are delivered at the rate of 100 per minute. The blows of the calks strike in nine concentric circles ¼ in. apart. To date, several hundred tests have been made with this machine. The reports in the table are representative.

PARTIAL RECORD OF IMPACT TESTS MADE BY THE NEW YORK STATE COMMISSION OF HIGHWAYS

Coarse Aggregate	Fine Aggregate	Mix	No.	Grams Lost per Test	Average Loss	Remarks
Trap	Sand, Niagara	1 : 1½ : 3	3	150-110 105-95	103	Small stone area omitted
Trap	Sand, Cowbay	1 : 1½ : 3	4	110-120 110-100	110	
Trap	Sand, Albany	1 : 1½ : 3	4	140-100 125-125	122	
Trap	Sand, Long Island	1 : 1½ : 3	2	120-135	127	
Trap	Sand, Marlboro	1 : 1½ : 3	2	130-135	132	
Trap	Tailings, graphite	1 : 1½ : 3	2	155-135	145	
Trap	Sand, Booneville	1 : 1½ : 3	4	165-130 165-135	149	Group (1) 103-165
Trap	Tailings, iron ore	1 : 1½ : 3	5	200-155 165-155 165-180	164	Excess grout omitted
Trap	Sand, Cowbay	1 : 2 : 4	2	150-150	150	Group (2) 150-175
Trap	Sand, Albany	1 : 2 : 4	3	180-160 185-225	175	Small stone area—excess grout omitted
Trap	Sand, Marlboro	1 : 2 : 4	2	180-170	175	
Syenite	Sand, Booneville	1 : 1½ : 3	8	150-145 150-140 145-125 185-130	141	Group (3) small stone area omitted 141-186
Syenite	Sand, Booneville	1 : 2 : 4	4	180-205 180-180	186	
Buffalo Limestone	Sand, Niagara	1 : 1½ : 3	5	150-120 155-125 135	137	Group (4) 137-170
Buffalo Limestone	Sand, Cattaraugus	1 : 1½ : 3	5	155-160 140-125 160-200	148	Excess grout omitted
Buffalo Limestone	Sand, Booneville	0 : 1½ : 3	4	180-160 185-160	171	

The results indicate that generally the average loss increases as the mortar strength of the sand decreases. An average loss for each test shows that there is greater strength in the 1 : 1½ : 3 mix than in the 1 : 2 : 4 mix. It is interesting to note that syenite, with a French coefficient of 12.5, shows, approximately, an equal loss under this test with Buffalo limestone with a French coefficient of 7.9. On the basis of the Deval test, the limestone is inferior for road purposes to the syenite, but service conditions indicate that the Buffalo limestone and many other limestones, with a French coefficient of 7 and better, are very satisfactory in service.

In the test to indicate strength, concrete from a batch is made up on the road into 6-in. cubes or 6 x 12-in. cylinders from every 500 cu.yd. or less of material. They are cured for 21 days in moist sand and then shipped into the laboratory and tested at 28 days. The following is a record of four years' work:

Years	Mix	Coarse aggregate	No. of cubes	Average compression per square inch
1915-16	1 : 1½ : 3	Stone	1684	3590
1917-18		Gravel	221	2950

It may be noted that a total of 1905 tests were made and that, with the exception of the gravel, they are well over 3000 lb. per square inch. When any individual test shows below 3000 lb., a thorough investigation was immediately made to determine the cause. While this occurred too late to correct the given piece of work, it had a good moral effect on the contractor, and a wholesome rivalry was inspired among the engineers to have a high test value for their work. The figures given above represent actual tests from the laying of something over 400 miles of 16-ft. concrete pavements of 6-in. average thickness.

Factors Influencing the Selection of Road Plant

By Arthur H. Blanchard
Consulting Highway Engineer, New York City

High wages for unskilled labor in 1917, 1918 and 1919, and the uncertain status of the labor supply of the future, have resulted in a thorough analysis of highway-construction data to determine economical methods of using road machinery. In the opinion of the writer, American highway officials must face high wages for unskilled labor for several years. It is not logical to expect that unskilled labor which entered the service will rush back to the pick and shovel after demobilization. Emigration records show that thousands of laborers are leaving America every month. Immigration, the usual source of supply of unskilled labor, is an unknown quantity. It is not surprising, therefore, that the reconstruction period finds highway officials, engineers and contractors investigating all types of labor-saving machinery.

Selection of Equipment

The selection of equipment for the construction and maintenance of highways should be based upon a consideration of the following factors: (1) Character of work; (2) specification requirements covering equipment; (3) amount of work; (4) portability of plant; (5) large and small units; (6) ease of manipulation; (7) adaptability to different classes of work; (8) funds available; (9) depreciation of plant; (10) transporta-

tion facilities. The practical necessity for the consideration of many of the above factors is self-evident.

Character of Work—In the case of contractors whose work is confined to the construction of sheet-asphalt pavements, and in the case of a department such as, for instance, that of Wayne County, Michigan, where the highway work consists primarily of grading operations and the construction of cement-concrete pavements, the problem is materially simplified. On the other hand, where a contractor's work covers the construction of the various types of roads and pavements used in a municipality, county or state, the selection of the several units of plant equipment should be based upon their adaptability to different classes of work.

Specification Requirements Covering Equipment—In the modern practice of highway engineering, many specifications include stipulations which must be met by the machines and accessories employed. Illustrations might be cited such as the weight of rollers, pressure limitations in distributors, grouting apparatus, and detals of mixers for the manufacture of bituminous concrete.

Amount of Work, Portability of Plant, Large and Small Units—It is evident that a contractor for a department will be justified in the purchase of an ideal equipment if the work is to be extensive in character. If the work is centralized and large in amount, as in the case of sheet-asphalt work in many municipalities, a large, well equipped, permanent plant will prove economical. If, on the other hand, the work is large in amount but distributed over considerable area, small, portable units will prove more satisfactory, as in the case of mixing plants for the manufacture of bituminous concrete to be laid on country highways.

Ease of Manipulation—In cases where contractors are engaged in general highway work and their organization does not include foremen who are specialists in the manipulation of various types of complicated machinery, it is of the utmost importance that simplicity of machines and ease of manipulation should receive great weight, in the selection of equipment. This is particularly true in connection with various types of machines used in the construction of bituminous surfaces, bituminous-macadam and bituminous-concrete pavements.

Adaptability to Different Classes of Work—It is well known that specifications for different classes of work, requiring the same type of machine, call for differences in detail. For grading work, specifications might require rollers weighing from 12 to 15 tons, while in the construction of wearing courses of some types of pavements a 10- to 12-ton roller is stipulated. A contractor who is handling a small amount of general highway work would find it advantageous, therefore, to purchase a 12-ton roller suitable for both classes of work.

Funds Available—Departments and contractors are necessarily forced to consider first cost of equipment, as the funds available may not permit the installation of the most economical and efficient machines. In many cases where such conditions are encountered it is obvious that it will not be practicable to anticipate that the work can be accomplished with the same degree of rapidity and at the same cost as if more efficient machinery were available.

Depreciation of Plant—Depreciation charges on plant should receive careful consideration, prior to the purchase of machines and accessories, as well as in the consideration of the cost of highway work.

Transportation Facilities—Facilities for the transportation of machinery and materials affect materially the efficiency of the several units of plant. For example, in municipalities, states and provinces where materials may be transported over highways in good condition, the use of the motor truck will usually be found desirable.

Filter Operations at Niagara Falls

OPERATING costs of the Niagara Falls municipal filter plant for the year 1918, taken from the annual report of B. T. Dignan, chemist in charge, indicate low unit costs. This rapid filter plant, which has a nominal capacity of 16,000,000 gal. daily, was described on p. 601 of *Engineering Record*, of June 1, 1912, the year of its completion.

For 1918 the bacterial count by months averaged 14, with high and low figures of 33 and 6. The removal ranged from 99.47% in December to 99.90% in January.

SEVEN YEARS' MECHANICAL FILTER OPERATING DATA AT NIAGARA FALLS, N. Y.

	Cost per 1,000,000 Gallons				
Year	Hypochlorite	Alum	Power	Labor	Total
1912	$0.00	$1.79	$1.82	$2.12	$5.73
1913	.04	1.25	1.97	2.46	5.72
1914	.10	1.00	2.16	2.99	6.25
1915	.08	1.10	2.38	3.73	7.29
1916	.25	.75	2.37	3.62	6.99
1917	.21	.75	2.14	3.16	6.26
1918	.14	.86	2.13	3.05	6.18
Average	$0.12	$1.07	$2.14	$3.02	$6.35

Bacterial Results, Alum Dose, Hypochlorite Rates and Typhoid Figures

Year	Bacteria per cc. on Gelatine	Per Cent. Bacteria Removed	Alum, Grains per Gal.	Price of Hypo. per lb. in N. Y.	Total Cases	Typhoid Deaths
1912	34	98.41	1.25	0.00	66	23
1913	32	98.71	0.87	2.67	26	10
1914	25	99.27	0.70	6.61	17	6
1915	12	99.62	0.77	5.02	10	0
1916	26	99.49	0.52	4.18	16	5
1917	15	99.69	0.41	4.35	13	3
1918	14	99.76	0.40	4.00	15	2
Average,	22.5	99.28	0.70	4.30		

Likewise, the variation in chemical-treatment cost varied only from $0.88 in October to $1.06 in February. Wash-water percentages varied from 1.16% in August to 2.74% in June, the higher figure being due to algæ growths in the lake shortening the runs. The average for the year was 2.05 per cent.

The typhoid situation has not changed from the enviable position held by the city, as noted by Charles B. Burdick in *Engineering News-Record* of Sept. 6, 1917, p. 440. It is pertinent to add that the Niagara River is continuously polluted by the raw sewage of 500,000 persons in Buffalo, 20 miles distant; also, that the municipal plant does not furnish all of the water to the city, but that the Western New York Water Co. supplies about 7,000,000 gal. daily of filtered and disinfected water to manufacturers and to 700 domestic consumers.

Kansas Water-Supplies To Be Studied

Research work planned by the Kansas State Board of Health includes water-works operation—particularly as to plants treating surface waters, swimming pools, sewage-disposal and the control of pollution of water-supplies by oil wells. F. M. Veatch is acting engineer of the division of water and sewage.

Women Water-Waste Inspectors at Baltimore, Maryland

Men Replaced With Satisfactory Results—Women Under Direction of Pitometer Engineer Paid $2.76 a Day

By Walter E. Lee
Water Engineer, Baltimore, Md.

WOMEN inspectors have taken the place of house-to-house men inspectors, for a year past, in the water-conservation campaign which is a part of the daily operation of the Baltimore Water Department.

The main campaign is based on pitometer surveys of consumption and leakage occurring on underground mains and services. Preceding the pitometer measurements, all leaks on plumbing in buildings are eliminated or repaired and stop-cocks on house service pipes are made tight, to cut off all demands effectively. This includes the overhauling of house service pipes, stop-cocks and boxes by construction gangs and house-to-house inspection of plumbing and sanitary fixtures in the district under investigation, by women inspectors working under the direction of a pitometer engineer. From the time water conservation was started in 1914 until Apr. 1, 1918, male inspectors were employed, averaging 50 to 100 inspections each per day, depending upon the character of the leakage found. The results obtained through the male inspectors were not altogether satisfactory, and, due to the effectiveness of women inspectors on mosquito-prevention work, it was decided to employ the same women permanently the year round, on house-to-house inspection.

INSPECTRESS LISTENING FOR WATER WASTE

The women inspectors are selected and employed on the basis of fitness, preferably between the ages of 30 and 45, and they must have good hearing to enable them to use the aquaphone in detecting wasting water on house-service pipes and plumbing. They must be neat in dress, quiet, mannerly and able to make direct replies to interrogations.

Each inspectress is equipped with an aquaphone for detecting water flow in the plumbing, a flashlight for use in cellars and basements, a street directory for the location of her daily assignment, and a stiff-back book holding her daily report sheets. The entire equipment is contained in a stiff leather case.

The hours of employment are from 8:30 a.m. to 5 p.m. five days in the week and to 3 p.m. on Saturdays, with one-half hour for lunch. The wage is $2.76 a day, or $16.56 a week. Twenty inspectresses are to be ultimately employed.

WATER DEPARTMENT CITY OF BALTIMORE
ENGINEERING AND CONSTRUCTION DIVISION.
S. W. Cor Oliver and Wolfe Sts

Date March 27 1919

To the occupant and to the owner of 600 E 42nd St

Notice is given that there is waste of water in the above premises due to leaking spigot in kitchen

If not repaired as required by law (City Code 1906, Art. 40) in 7 days, the water will be turned off.

Served by Mrs C.B. Stewart Inspector. WALTER E. LEE, Water Engineer.

Received by Mrs. E. M. Brown on premises.

1086-1-18-19-A Co.-100 B-200 L.

WATER WASTE NOTICE SERVED ON CONSUMERS
Original slip 4¾ by 3¾ inches, thin paper

A year's experience demonstrates that results are better than with men inspectors, for in such house-to-house inspection a municipality must always deal with the housewife or maid servant, and women inspectors can better educate them as to the object of the survey.

When water waste is found on any premises inspected, either through a split service pipe or a leaking plumbing fixture, a notice is served on the occupant of the premises and a reinspection is made one week from the serving of the notice, to see whether repairs have been made.

CITY OF BALTIMORE
HOUSE INSPECTION
WATER DEPT
E. & C. DIVISION

Pitometer Dist. M Sec. 15 Service Middle
Location E. 42 nd St

NOTE.—WHEN TRANSFERRING SHEET FROM BOOK TO FILE CUT OFF MARGIN

H. O. No.	Date Insp.	Leaks: Inside Stop	Leaks: Outside Stop	Leaks: Gallons Per Day	No. of Persons	Turn-Off	Turn-On	Remarks
600	3/2/18	J			6			In bath
	3/27/19	Sp			6			In kitchen
602	3/2/18	M			3			In cellar
	3/27/19	J			3			In bath
604	3/2/18				4			Hose on pipe
	3/27/19				4			OK
606	3/2/18	Sp			6			In kitchen
	3/27/19				6			OK
						Mrs C.B. Stewart		

H.—Hopper Sp.—Spigot
St.—Stop Su.—Supply
St.—Syphon T.—Toilet
F.—Footway Y.—Yard

CONTINUOUS RECORD FOR WATER-WASTE INSPECTIONS
Original, 5 by 6 inches on thin paper, with duplicate on reverse side

A schedule of house-to-house inspection is arranged so that each property receives about three inspections a year, and provision for subsequent inspections is provided for on the report sheet showing the style of the fixture that is leaking and its location on the premises.

The Numerical Interpretation of Bacteriological Tests

Theory of Probabilities Applied to Sanitary Engineering, With Particular Reference to Results Obtained in Studies of Water and Sewage

By Milton F. Stein
Civil Engineer, Chicago, Ill.

IT IS a peculiarity of the human mind that in any comparison other than the most elemental there is always an urgent desire to resort to the use of numbers. This holds true in the case of bacterial work, as is evidenced by the various attempts to express the complex bacterial characteristics of a water or sewage by a single index number. It is highly desirable, for purposes of comparison and standardization, that such results be numerically expressed, and it is the purpose of this article to explain the proper methods of numerical interpretation and to point out certain conditions which must be met, and certain limitations which must be submitted to. The methods given are based on the theory of statistics and probabilities. It is not intended to explain the underlying theories, which have been fully developed elsewhere, as given in the references, but simply to state the principles involved and to show their practical application.

To avoid confusion it may be well to define the use which will be made, for the purpose of this article, of certain terms commonly used indiscriminately:

By a *sample* will be meant the quantity of liquor, removed from the main body thereof for testing purposes, and which may be of any size, from the usual bacterial sample to one or more gallons.

By a *test* will be meant the operations involved in developing and counting the colonies on a single plate, or in producing and recording a result in a single fermentation tube. Thus, a *sample* may be subjected to but one *test* or to a number of *tests*. The *quantity tested* will refer to the amount involved in each test—10 cc., 1 cc., 0.1 cc. or other fractional part, this quantity being often called the *size of sample*.

There are evidently two kinds of bacterial results to be considered: (a) Those based on a *single sample*, such as would be made on the same portion of a liquor at each of the several steps in a continuous process of purification, to determine the changes or improvement effected, or on a definite, limited quantity of liquor to determine its bacterial condition; (b) those based on *repeated samples*, such as routine results obtained from day to day in filtration plants and sewage-disposal works.

There are two types of tests usually made: (a) *Numerical tests*, such as the usual bacterial count; (b) *tests of attributes*, involving the presence or absence of some one attribute or characteristic, as the presence or absence of gas in the fermentation test used in the detection of the colon bacillus in water.

Arithmetic Mean the Best Average—In averaging a number of tests, either on a single sample or on repeated samples, the ordinary arithmetic mean gives the most logical result, being rigidly defined and based on all the tests made. Its significance is readily comprehensible and it lends itself to simple computations. The use of the median, or the middlemost value of a series when these are arranged in the order of their magnitude, has been proposed, because in it the effect of exceptionally large and small values upon the average are partially neutralized, but no reasons have been advanced why such divergent values are entitled to less consideration than the rest. The geometric mean has some advantages in special cases, but its nature is not generally understood, and its calculation is rather involved.

The Expected Error—The expected error is sufficiently defined by its name. The formulas for it are derived by means of the theory of probabilities, assuming certain ideal conditions to exist. As applied to bacteriological tests these conditions would be:

1. That all bacteria in the liquor sampled are identical in all characteristics affecting the results of the tests, such as rate of growth, vitality, effect of environment, etc.

2. That, in single samples, the distribution is essentially uniform, and, in repeated samples, the number in the liquor does not vary from sample to sample.

3. That all the bacteria are independent, in the sense that one does not hinder the development of another by overgrowths, toxic products, etc.

In the conventional interpretation of the bacterial count these conditions are assumed to obtain, in that no allowance is made for unequal distribution of bacteria in the liquor, and all the bacteria plated are supposed to produce visible colonies within a specified time and without mutual interference. We know that such an ideal state of affairs does not hold, and it is one of the tasks of the statistical method to devise a measure of departure therefrom.

The rules for finding the expected error are:

1. The expected error in the number of colonies on a single plate is equal to the square root of that number. If a dilution is used in the test, then the expected error in bacteria per cubic centimeter is obtained by multiplying the square root of the plate count by the dilution factor, just as the plate count must be multiplied by the dilution factor to give the bacteria per cubic centimeter.

2. The expected error in the number of colonies on any plate of a series made from the same sample is equal to the square root of the arithmetic mean number of colonies per plate in the series. Here, again, results must be multiplied by the dilution factor to apply to bacteria per cubic centimeter.

The general formula (See Stein, "A Critical Study of the Bacterial Count," in *American Public Health Journal* of November, 1918) for these rules is:

$$\epsilon(\alpha) = \sqrt{\frac{\alpha}{n}}$$

$\epsilon(\alpha)$ = The expected error in the number of bacteria per cubic centimeter in any one test.

α = The number of bacteria per cubic centimeter as determined by a single test, or, better, by the mean of a number of tests.

n = The dilution factor, 10, 100, 10,000, etc., as the case may be.

Theoretically, α should be the actual number of bacteria per cubic centimeter, but since this is not known exactly, the best value available should be used, which is the mean of the available tests.

The expected error of the mean of a series of tests is obtained by dividing the expected error for a single test by the square root of the number of tests in the series, or

$$e(M) = \frac{e(a)}{\sqrt{N}}$$

M = The mean number of bacteria per cubic centimeter.

N = The number of tests in the series.

THE STANDARD DEVIATION—If a number of tests are made on the same sample the results will in general differ among themselves and also from the arithmetic mean. Some measure of this deviation from the mean is necessary in order to establish the accuracy of the latter quantity. If, following a natural and logical impulse, we attempt to find the mean value of these deviations, with due regard to signs, we are baffled by the result, which is invariably zero. It is therefore customary first to square these deviations, which at once eliminates the difficulty of signs, then to find the mean, and extract the square root thereof.

The result is called the *standard deviation.*

It may be formulated as follows:

$$\delta = \sqrt{\frac{(a_1 - M)^2 + (a_2 - M)^2 + \ldots (a_N - M)^2}{N}}$$

δ = The standard deviation.

$a_1, a_2 \ldots a_N$ = Bacteria per cubic centimeter as determined by the different tests.

M = Mean value of bacteria per cubic centimeter.

N = Number of tests made.

There are good theoretic reasons for the use of the standard deviation as a measure of dispersion, not the least of these being that, under the ideal conditions given previously, it is equal to the expected error.

The standard deviation or "mean error" of the mean is given by the formula,

$$\delta_M = \delta/\sqrt{N}$$

THE LEXIAN RATIO—Since, under the ideal conditions, tacitly assumed in the bacteria count, the standard deviation is equal to the expected error, the ratio of the former to the latter is a measure of the departure from these ideal conditions. This is known as the Lexian ratio, and is given by the formula $L = \delta/\epsilon$.

If the conditions are "normal," as assumed, this ratio will be equal to 1. If the distribution of bacteria is irregular, and the usual small accidents and interferences in plating and counting occur, the Lexian ratio will be greater than 1.

APPLICATION TO THE BACTERIAL COUNT—*I. The Single Sample; a. Single Test*: In Fig. 1 the expected errors in a single test for various numbers of bacteria per cubic centimeter are shown for tests of 1-cc. quantities. For other dilutions multiply the expected error as shown on the diagram by the dilution factor. *Example:*

A single plating of a sewage sample at 10,000 dilution gives a count of 256 colonies. This is equivalent to 256 × 10,000, or 2,560,000 bacteria per cubic centimeter. From Fig. 1 the expected error for 256 is 16, which multiplied by 10,000 gives an expected error of 160,000 bacteria per cubic centimeter. The largest error which may be reasonably expected is three times the expected error, in this case 480,000 per cubic centimeter.

Fig. 2 shows the expected error in per cent. for various numbers of colonies per plate, and may be called a *precision curve.* It shows very clearly that *to reduce errors in the bacterial count, dilutions should be used giving 200 or more colonies per plate.*

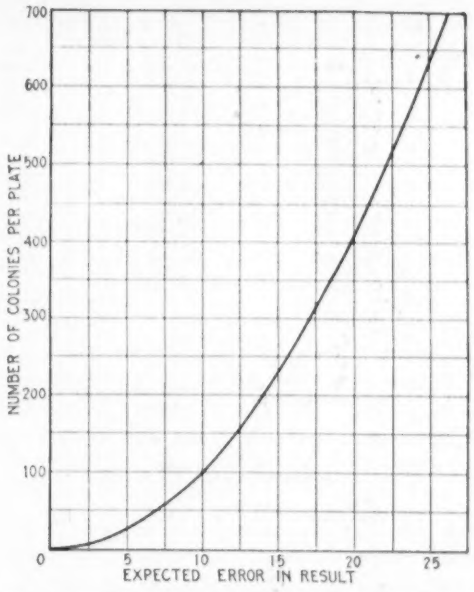


FIG. 1. CURVE SHOWING EXPECTED ERROR IN BACTERIAL COUNTS

b. Series of Tests: The method of treatment is best shown by the example given in Table I. Two of the 15 tests made on the sample were discarded. The average of the remaining 13 was then found. The difference between each result and the mean is given in the second column, and the square of the difference in the third column. The square root of the sum of these squares divided by 13 gives the standard deviation.

In finding the expected error, Fig. 1 is entered, using the mean count, 398.4, the corresponding expected error, 20, being multiplied by 10,000, the dilution factor. This expected error, divided by $\sqrt{13}$ gives the expected error of the mean. The Lexian ratio is exceptionally low, showing as close an approach to the assumed conditions as is usually obtained. Values from 4 to 6 are more common for tests on single samples. The results are exceptionally accurate and show what can be hoped for with careful work.

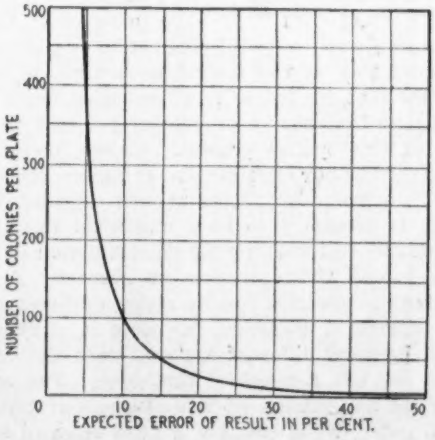


FIG. 2. THE PRECISION OF BACTERIAL COUNTS

TABLE I. TESTS ON A SINGLE SAMPLE OF RAW SEWAGE

Incubation, 24 hours at 37° C. Dilution, 1/100 x 1/100
Controls, 0-0-0. Special care used

	Count	Deviation	Deviation [2]
1	3,780,000	204,000	41,600,000,000
2	4,340,000	356,000	126,600,000,000
3	3,800,000	184 000	33 900,000,000
4	840,000 (omitted)	.....	.....
5	4,280,000	296,000	87,600,000,000
6	3,340,000	644,000	414,000,000,000
7	3,980,000	4,000	16,000,000,000
8	3,300,000	684,000	466,000,000,000
9	4,370,000	386,000	149,000,000,000
10	4,160,000	176,000	31,000,000,000
11	4,060,000	76,000	5,760,000,000
12	3,730,000	254,000	64,500,000,000
13	3,650,000	334,000	111,200,000,000
14	5,000,000	1,016,000	1,030,000,000,000
15	Overgrowths	.....	.....
Mean	3,984,000	.....	2,577,160,000,000

Standard Deviation $\sqrt{\frac{2,577,160,000}{13}} = \pm 445,000 = \pm 11.2\%$

Maximum Deviation $\begin{cases} = + 1,016,000 = + 25.5\% \\ = - 684,000 = - 17.1\% \end{cases}$

Expected Error = $\sqrt{398.4 \times 10,000} = \pm 200,000 = \pm 5.0\%$

Lexian Ratio = $\frac{445,000}{200,000} = 2.2$

Mean Error = $\frac{445,000}{\sqrt{13}} = \pm 123,000 = \pm 3.1\%$

II. *Repeated Samples*—Repeated samples are to be considered the usual routine tests, one or more per day, made in water-works and sewage laboratories. The essential difference, as compared to the single sample, is the variation from sample to sample, in the bacterial content of the liquor being examined, due to river fluctuations, wind currents, seasonal changes, etc. Considerable importance is usually placed upon monthly and even yearly averages of daily tests. These, in themselves, while not to be ignored, should not be given undue weight, unless accompanied by the standard deviation and Lexian ratio, which will give an idea of the variation from ideal conditions. In sanitary work particular interest attaches to exceptionally large values, which calls attention to the individual samples tested. In order that the results of these may be reasonably reliable, the writer recommends that two conditions be observed: (1) Use such quantities in the tests as will give 200 or more colonies per plate, if possible; (2) make from three to 10 tests of each daily sample. Plotting the daily results graphically in the order of their magnitude gives a very clear picture of the type of distribution.

Repeated samples are computed exactly as are repeated tests on single samples, but generally the Lexian ratio will be much larger, from 5 to 15.

THE BACILLI COLI TEST—The presence of the colon bacillus in a water-supply is indicative of pollution, and a consideration of the factors governing its presence will show that the intensity of pollution must be proportional to the density, or number per unit volume of water, of this species present. Unless, therefore, we wish to restrict our classification of waters, according to this test, to polluted, if present, and unpolluted, if absent, it is necessary to have numerical results. The fermentation test used in the determination of coli indicates merely their presence or absence. A certain percentage of positive results gives no direct measure of the degree of pollution, nor does it allow of comparison between different waters, since the causative factors are not necessarily the same. The combination of the percentages of several series of tests, as in the coli index, while creating a false sense of security, through its apparent definiteness, only serves to obscure actual conditions the more. While some method of direct counting would be highly desirable, the best that can be done, in its absence, is to interpret the fermentation test by means of the laws of probability, under certain well defined restrictions, and with a full appreciation of the limits of accuracy involved.

Such a method was described by the writer in a previous article ("Making the B. Coli Test Tell More," Stein, *Engineering News-Record* of May 24, 1917, p. 391) and the theory and application were more fully discussed in a pamphlet privately circulated. For cases of a number of tests made upon a single sample this method gives the very simple formula, $x = -\log_e Q$, where x = the number of coli in the quantity tested, and Q = the proportion of negative tests in the series.

By using 1-cc. quantities x becomes the number of coli per cubic centimeter. The curve for 1-cc. tests is shown in Fig. 3. For other sizes of tests it is necessary to divide by the size of test to obtain the number of coli per cubic centimeter. By use of this curve it becomes a simple matter to find the most probable number of coli for any percentage of positive tests.

The corresponding formula for the expected error becomes rather involved, but the values for 10, 30 and 100 tests are shown graphically in Fig. 4, and the desired values can be picked therefrom. For sizes of tests other than 1-cc., division by the size of test is necessary to obtain results per cubic centimeter.

In Fig. 5, the expected errors have been plotted as percentages. This may be called the precision diagram and is of considerable interest. It brings out:

1. *Ten tests are the least that should be used in determining the percentage of positive tests in a single sample.* Ten tests give an error of from 45% to 50%, which is certainly quite large, but the burden of laboratory work involved in making a large number of tests upon each of a continuous series of routine samples evidently requires some consideration. The error can be reduced in proportion to the square root of the number of tests made. Thus, for 100 tests the error for 10 tests should be divided by $\sqrt{10}$, for 200 by $\sqrt{20}$, etc. To obtain results within $\pm$ 10% requires 200 tests, $\pm$ 5%, 800 tests! It is unfortunate that this test, of much greater sanitary significance than the bacterial count, should be so inexact.

2. *For reliable results, the percentage of positive tests should lie roughly between 35 and 85.* Closer limits can be obtained by inspection of the individual precision curves. Below 35% the error increases very rapidly and above 85 the curves abruptly change their slope and pass into a region of indetermination.

3. *Of three dilutions in the usual geometrical progression of 10, 1.0, 0.1, only one can be in the range of reliable results.* This follows directly from (2) and has been checked by the examination of a large number of actual results. A coli value by the method given above, based upon the combination of three dilutions, is less exact than would be obtained by selecting the one of the three which lies within the range of reliable results. This point applies with even greater force to the coli index, since therein the lower of the three values is given 10 times the weight of the middle (and usually the most accurate) one. Of course, dilutions closer together might be used, but then there is the possibility of all of them being outside of the limits, so that it is better to use the multiples of 10, and select that set which comes within the range.

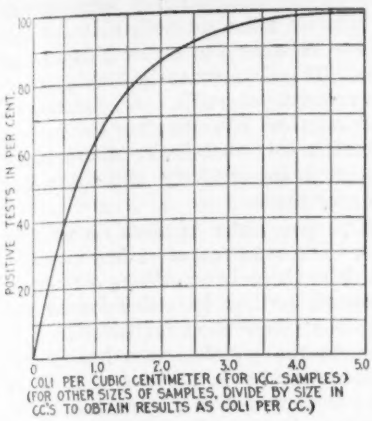

POSITIVE TESTS IN PER CENT.
COLI PER CUBIC CENTIMETER (FOR ICC. SAMPLES)
(FOR OTHER SIZES OF SAMPLES, DIVIDE BY SIZE IN CC'S TO OBTAIN RESULTS AS COLI PER CC.)

FIG. 3

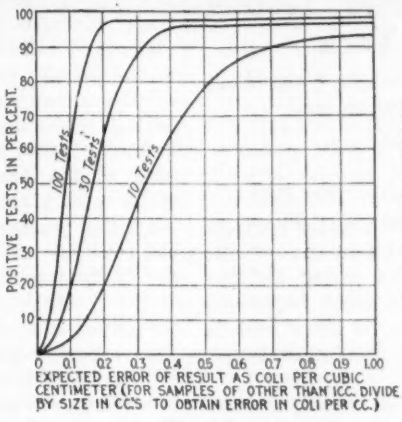

POSITIVE TESTS IN PER CENT.
100 Tests
30 Tests
10 Tests
EXPECTED ERROR OF RESULT AS COLI PER CUBIC CENTIMETER (FOR SAMPLES OF OTHER THAN ICC. DIVIDE BY SIZE IN CC'S TO OBTAIN ERROR IN COLI PER CC.)

FIG. 4

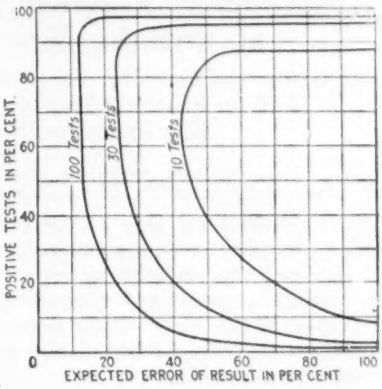


FIG. 5

FIG. 3. MOST PROBABLE NUMBER OF COLI CORRESPONDING TO ANY PERCENTAGE OF POSITIVE FERMENTATION TESTS. FIG. 4. THE EXPECTED ERROR IN COLI RESULTS. FIG. 5. THE PRECISION OF COLI RESULTS

THE BACILLI COLI TEST—REPEATED SAMPLES—If there is so much uncertainty in the results of fermentation tests on a single sample, how must matters stand in the case of repeated samples, such as the daily tests (usually one each of several dilutions) made at filtration plants? The density of coli in almost every water varies from day to day, so that the daily results are in fact only single tests taken haphazard from a number of series, each of which, if developed, would yield a different percentage of positive tests. Therefore, unless it is definitely known that the coli content of a water is practically constant from day to day, any percentage or other computation based on a series of single daily tests is of little value, and unless such a constancy has been experimentally verified it is necessary to make a series of tests, not less than 10, each day, if it is desired to avoid the danger of being entirely misled by the results.

This may be shown by Table II, which represents the results of 10 tests on a single sample each day for 10 days. The mean number of coli was 0.91 per cubic centimeter. If only one test had been made each day, the results obtained might have been as in column 3, which gives 0.3 positive, or 0.35 coli per cubic centimeter, or they might have been as in column 6, —0.8 positive or 1.6 coli per cubic centimeter or any one of many other combinations.

TABLE II. RESULTS OF DAILY SERIES OF COLI TESTS FOR 10 DAYS
(1-cc. samples)

Column	1	2	3	4	5	6	7	8	9	10	*P*	Coli
Monday	+	—	+	—	+	—	—	+	+	+	0.6	0.9
Tuesday	—	+	—	+	—	+	—	+	—	—	0.4	0.5
Wednesday	—	—	—	+	+	+	+	+	+	+	0.7	1.2
Thursday	—	+	—	—	—	+	—	—	—	+	0.3	0.35
Friday	+	+	+	+	+	+	+	+	+	—	0.9	2.3
Saturday	—	—	—	—	—	+	—	—	—	—	0.1	0.1
Sunday	—	+	—	—	—	+	—	—	—	—	0.2	0.2
Monday	—	—	—	+	+	+	+	—	+	+	0.5	0.7
Tuesday	+	+	+	+	—	+	+	+	+	—	0.8	1.6
Wednesday	+	+	—	+	+	—	+	—	+	+	0.7	1.2
Mean												0.91

Assuming that 10 or more tests are made per day, the summarizing of results for 10 days, 30 days or for a longer period is very similar to the method used for the bacterial count. Using the data in Table I, the procedure is shown in Table III, and calls for little comment. If 0.1-cc. samples had been used, it would have been necessary to multiply the values under "Coli" by 10; whereas if 10-cc. quantities had been used, the same values would have been divided by 10, as previously explained.

TABLE III. THE STATISTICAL COMPILATION OF BACILLI COLI TESTS
1-cc. Samples

Date	*P*	Coli	Deviation	Deviation
1/11	0.6	0.9	0.0	0.00
1/12	0.4	0.5	0.4	0.16
1/13	0.7	1.2	0.3	0.09
1/14	0.3	0.35	0.00	0.30
1/15	0.9	2.3	1.4	1.96
1/16	0.1	0.1	0.8	0.64
1/17	0.2	0.2	0.7	0.49
1/18	0.5	0.7	0.2	0.04
1/19	0.8	1.6	0.7	0.49
1/20	0.7	1.2	0.3	0.09
Mean		0.9		4.26

Standard Deviation = $\sqrt{\frac{4.26}{10}} = \pm 0.65 = \pm 72\%$.

Expected Error = Value *P* corresponding to 0.9, from Fig. 3 = 0.6; from Fig. 4, the expected error for $P = 0.6$ and 10 tests is ± 0.38.
Lexian Ratio = $0.65/0.38 = 1.71$.

Mean Error = $0.65/\sqrt{10} = \pm 0.21 = \pm 32\%$. This value is included merely to show the method of computation. Where results are very irregular its use is not warranted.

New Projection in Map of United States

Using a new system of projection, known as the Lambert conformal conic projection, the United States Coast and Geodetic Survey has just issued an outline map of the United States, scale 1: 5,000,000 and 25 x 39 in. in size. By this system of projection the average scale error is much reduced from that in other systems commonly used. For instance, between latitudes 30½° and 49°, the maximum scale error is only ¼%. The Lambert projection is well adapted to large areas of predominating east and west dimensions as the United States, where the distance across from east to west is 1⅔ times that of the distance north and south. The strength of the polyconic projection, on the other hand, is along its central meridian. Special features of the Lambert projection that are not found in the polyconic are claimed as follows: (1) The Lambert projection is conformal; that is, all angles between intersecting lines or curves are preserved; and, for any given point (or restricted locality), the ratio of the length of a linear element on the earth's surface to the length of the corresponding map element is constant for all azimuths or directions in which the element may be taken; (2) the meridians are straight lines and the parallels are concentric circles; (3) it has two axes of strength instead of one, the standard parallels of the map of the United States being latitudes 33° and 45°, and upon these parallels the scale is absolutely true.

Water-Meter Practice and Testing at Buffalo, New York

Special Testing Bench for Large Meters, Cubic-Foot Pail for Skeptical Householders, and Non-Freeze Settings

By Carl L. Lund
Hydraulic Engineer in Charge of Buffalo Meter Shop

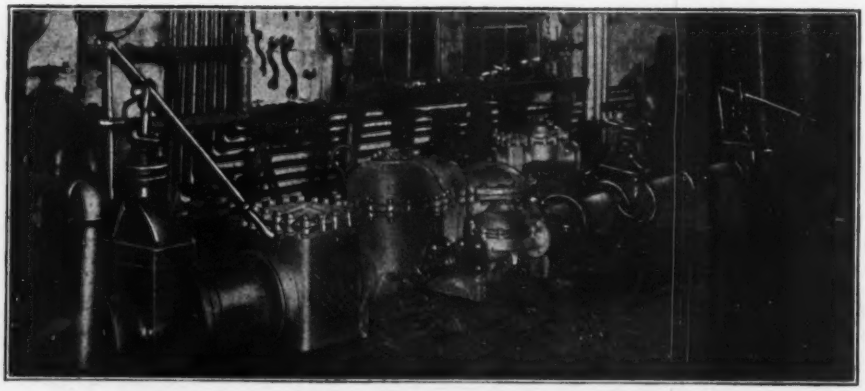
ALTHOUGH 7% only of the 75,325 water services in Buffalo, N. Y., are metered, 46% of the revenue is obtained for metered water. The meter division is, therefore, considered one of the most important branches of the water department. To show how it functions from initial installation to final replacement is the present object.

The city furnishes and installs all water meters, making a nominal charge for labor and fittings. All meters are maintained without expense to the consumer unless the meter should disappear; then he pays for it. If the meter should be ruined by hot water or be frozen, the consumer pays for the damage. A charge is made also for repairing or changing meters after the working hours of the water-department employees. It happens frequently, especially in the large office buildings or offices of corporations, that when we ask, "What is a convenient time to make the repairs?" the reply is, "After we have shut down for the day." In 90% of these cases, when the consumer is informed that he will have to pay for the overtime of the men he finds time to permit the making of the repairs in working hours. Furthermore, if this were not done it would be an inducement to the employees to put off the repairs for the overtime.

Meters are installed in the buildings as far as possible, but where the connections are such that this cannot be done the ⅝-in. and ¾-in. meters are placed near the curb in an 18-in. tile with an iron cover and an 11-in. opening. The larger meters are installed in concrete vaults with a flat-iron frame and cover made by a local foundry. The small meters of the outside installation are brought up to within 15 in. of the surface, and the tile is filled to within 6 in. of the meter. During the severe winter of 1917-18 only half a dozen of the outside meters were frozen, and in each case the service froze in the building first. In the same winter there were over 100 meters frozen inside buildings. A yoke with a stop-cock at each end is used for the small outside installations, as it saves time in changing meters. In the installation of large meters the department requires a valve on both sides of the meter and a 2-in. tee between the outlet side of the meter and the valve. This is for use in making tests of the meter at frequent intervals. A siamese or battery connection is required so as to place two meters instead of one, as with this installation there is no need of the consumer being entirely without water while repairs are being made.

At the present time five meter readers do nothing but read the meters. The readings are taken monthly, and if the reader thinks there is something wrong, or if the meter is stopped, he has an order issued and the meter is sent to the meter shop for investigation. This order is given to the plumber who has charge of the district, and unless he is positive that there is nothing wrong he is supposed to change the meter. We have found that time is saved by taking the meter to the shop, as the disk may be broken, the spindle worn, the train-gear gone, the pinions stripped, or parts of the dial loose. Should the meter reader find a large discrepancy in the previous consumption, he has an order made to investigate for leaks, and the bill is not sent to the consumer until the investigation is made and we are positive that the reading is correct. No complaints are received of under-registering of the meters, but as soon as a bill rendered is larger than usual we are notified that the meter is wrong. For complaints of small meters we make a test on the property by using a 7½-gal. copper pail. For the large meters we use a 2-in. meter and test the two meters in tandem, through the 2-in. test tee. We find the cubic-foot pail more satisfactory to the water-rate payers, as they are always skeptical of a meter.

It is the intention to change meters every two years or oftener, according to consumption. The Lake Erie water is turbid at times, filling the meter with silt. This is bad for the rotary meter, which will under-register 12% in two years. According to the Buffalo rules, meters must register within 2%, plus or minus, and must register water through a ¼-in. opening before it can be reset. We find that it is impossible to get the meter to run on a smaller stream without spending a greater amount of time than is commensurate with the revenue we receive at 4c. per 1000 gal. At 40-lb. pressure (which is higher than the average) we find that a meter repaired in the shop and tested perfectly on all streams, including ¼-in., will, after a few days, be brought back to the shop, and the best we can get this meter to do is a ½-in. stream.



TESTING OUTFIT FOR LARGE METERS HAS QUICK-OPENING INLET AND OUTLET VALVES

The meter-repair division is located in a one-and-a-half story brick building at Lake View Ave. and Jersey St., in conjunction with the general repair division. It is also near the Col. Francis G. Ward pumping station. The meter shop is 200 ft. x 50 ft., with a stock room 20 ft. x 40 ft. in the center and adjacent to the meter repairer's bench. In the stock room are 1300 compartments for fittings and repair parts. From a 48-in. main in Lake

View Ave. there is a 10-in. connection for the shop. A 2-in. line supplies the testing machine for small meters up to 2-in. A special testing bench, designed and constructed by the writer, is used for the larger meters. The layout is as follows: A 10-in. supply comes into the building and up to a 10-in. flanged quick-opening valve (there is a 10-in. air chamber just inside the building wall); then a 10 x 8-in. flanged reducer, followed by an 8 x 6-in. flanged reducer, then a reducer to fit any size of meter, and, finally, space for a meter. The line is then increased to a 6-in. screw gate valve, and a piece of 6-in. pipe is followed by a 6-in. quick-opening valve. On this piece of 6-in. pipe there is a special flanged joint for inserting bronze disks with openings of various sizes, from 4 to ½ in. The discharge is through a 7-ft. riser over the top of a 60-in. cast-iron pipe set on end on a concrete foundation, with a 6-in. outlet to the sewer. The outlet is controlled by a 6-in. quick-opening valve. This is a volume tank, and the amount of water that is registered shows through glass gages in three 4-ft. sections, with a wood board painted to show cubic feet. The bottom of the 60-in. pipe is 5 ft. below floor level, with the zero of the gage at floor level, so zero is always at water level. A third testing machine is used by the meter repairers to tell how small a stream the meter will register.

The present force and the salaries of the meter division are as follows: One general foreman, $1500 per year; one clerk, $1200 per year; two plumbers, $110 per month; three meter repairers (outside work), $4 per day; two meter repairers (shop work), $3.75 per day; one repairer and tester (large meters), $3.75 per day; four plumbers' helpers, $3.25 per day; one plumber's helper, $3 per day; one meter tester, $3 per day, and one laborer, $3 per day. The Bureau of Water is under the Department of Public Works, of which Arthur W. Kreinheder is commissioner and George C. Andrews is water commissioner. The writer is hydraulic engineer in charge of the meter shop.

Design and Tests of Highly Efficient Air-Lift Installation at Fort Bliss, Texas

Novel Foot Piece, Well Proportioned Eduction Pipe, and Special Head Tanks Give 51.9 Per Cent. Air-Lift Efficiency—Overall Efficiency 28.6 Per Cent.—Test Figures and Operating Costs Given

By Captain J. F. Brown
Quartermaster Corps., Engineering Branch, Construction Division of the Army, Kansas City, Mo.

In the light of experience, extending over several decades, in the use of compressed air for lifting water from wells, engineers are inclined to receive, not without a degree of skepticism, reports of actual installations which are operating at high efficiency. Careful analysis of conditions to be met and thorough study of plants of a similar character, on the part of the designing engineer, have, however, made possible the design and installation of such a plant at Fort Bliss, Texas, tests of which show operating efficiencies never before attained—51.9% as the average of the better of two sets of air-lift tests and 28.66% as the corresponding overall or wire-to-water efficiency. The foot piece, consisting of a double conical bronze casting (inverted cone at lower end), set within and at the foot of the eduction pipe, is the special feature of design. Particular attention was also given to the proportions of the eduction pipe and to the head tanks at the top of each eduction column. Small water-storage reservoirs, with sand-settling compartments and measuring weirs, are provided.

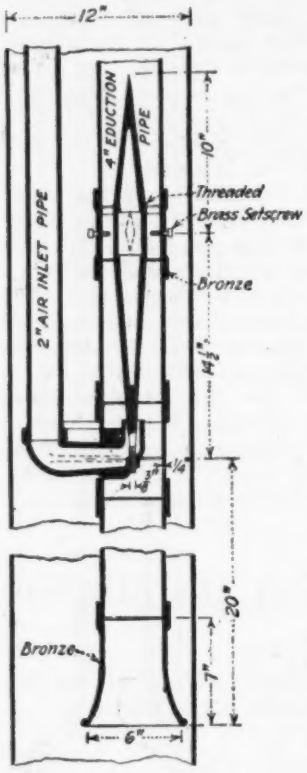
Water for all needs of the permanent military establishment, as well as for several bodies of troops encamped temporarily on the Fort Bliss military reservation, is supplied from four bored wells, each 600 ft. deep, and is pumped from these wells into surface reservoirs by means of compressed air. From the surface reservoirs the water is pumped directly into the distributing mains by means of centrifugal pumps. According to information obtained during the drilling of the wells, eight distinct water-bearing strata are penetrated, the first, or uppermost, being about 220 ft. below the surface, at which depth is the normal water plane.

These wells, two of which are 10 and the other two 12 in. in diameter, are cased to the full depth with standard threaded steel casing. From the normal water plane to the bottom the casings are perforated with ½ x 10-in. vertical slots, the area of opening being 10 sq.in. per foot of casing. In the 10-in. wells drilled in 1913 the slots were cut by means of air-operated hammers, while in the larger wells, drilled in 1917, they were cut by means of an oxyacetylene torch. The latter method proved to be much more rapid and less costly than the former.

Air for operating the four wells is supplied by four duplex, two-stage compressors, two of which are equipped with high- and low-pressure cylinders 7½ and 14 in. in diameter, respectively, the other two being equipped with cylinders of 7- and 12-in. diameters, respectively, and all having a 12-in. stroke. At the normal speed of 190 r.p.m., the two larger compressors deliver 320 cu.ft. of free air per minute each, and the smaller ones 260 cu.ft. each, when operating against a terminal gage pressure of 150 lb. The cylinders are equipped with Corliss-type intake and direct-lift-type discharge valves, and are water-jacketed. Each compressor is provided with a brass-tube intercooler having a cooling surface of 50-sq.ft. area.

All of the compressors discharge into a 6-in. header, at each end of which is an air receiver 3½ ft. in diameter and 10 ft. long. From each receiver compressed air is distributed to two wells, the air-supply line to each well being 3 in. in diameter. At the well head the air line is reduced to 2 in. and extends into the well between the casing and the eduction column to a depth of approximately 540 ft., at which point it connects into a specially designed cast bronze foot piece.

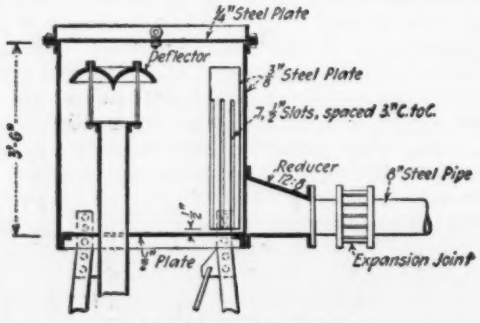
The function of the foot piece, shown (see next page) is to facilitate the thorough mixing of the current of air and the rising column of water. This highly important feature of the installation differs radically from the well-known commercial types of foot pieces. It consists



AIR LIFT FOOTPIECE

essentially of a double conical bronze casting supported concentrically within the eduction column, the apex of the lower cone extending just into the compressed air inlet. From this point the velocity of the rising column of water is increased, due to the decreased area of the section, until the throat section at the base of the cone is reached, at which point the velocities of the two currents are very nearly equal. In this portion of the foot piece there occurs the thorough mixing of air and water, the two fluids passing through the throat section in a thin sheet or film. The upper cone serves to provide a steadily increasing section, thus preventing a separation of air and water which would be caused by the shock due to a suddenly increasing section. The eduction column was designed of such proportions that the maximum velocity of the rising column of water and air should not exceed 25 ft. per second at any point when the well was delivering at the normal rate, and increases in diameter from 4 in. at the foot piece to 7 in. at the top.

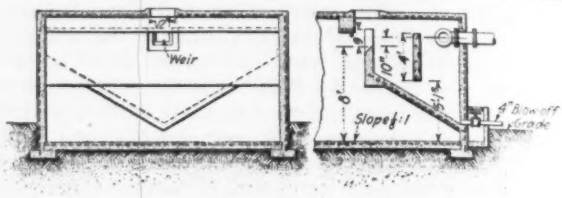
At the upper end of each eduction column is a cylindrical steel head tank (see below), 3½ ft. in diameter and 3½ ft. in depth, within which is supported, just above



AIR LIFT HEAD TANK

the end of the pipe, an umbrella-shaped cast-iron deflecting vane, whose function is to break the force of the rising column of water and air. The head tanks are closed at their tops by means of steel plates, bolted on over rubber gaskets to prevent the escape of air. From the head tanks water and air flow through 8-in. galvanized-steel pipe lines supported on angle-iron frames and concrete piers, to two covered rectangular reinforced-concrete reservoirs of 46,000 gal. capacity each. Each reservoir contains a small settling chamber, in which the sand coming from the wells subsides, and a rectangular weir for measuring the rate of discharge from the wells. (See illustration below.)

Horizontal, double-suction, single-stage, volute-type, centrifugal pumps are used for pumping the water



RESERVOIR WITH SAND-SETTLING COMPARTMENT AND WEIR

from the surface reservoirs into the distributing mains. There are four of these pumps, each rated to discharge 600 gal. per minute against a head of 135 ft. at a speed of 1760 r.p.m., although two of them have a discharging rate of about 1000 gal. per minute when operating against that head.

All of the compressors and centrifugal pumps are driven by constant-speed, induction-type motors. The motors for the two larger compressors are rated at 75 hp. each and operate at a speed of 580 r.p.m., while those for the two smaller compressors are rated at 61 hp. each and operate at a constant speed of 1150 r.p.m. Each centrifugal pump is direct-connected by means of a flexible coupling to a 40-hp. motor, which operates at a constant speed of 1760 r.p.m. Electric current for operating these motors is bought from the El Paso Electric Railway Company.

Upon completion of the original installation, consisting of the two larger compressors and two centrifugal pumps, a series of tests, or trial runs, was made to ascertain the efficiency of operation of the plant, particularly of that portion of the plant used for lifting water from the wells. During the past year the capacity of the plant has been practically doubled by the installation of additional compressors and pumps, and upon completion of this work a second and more comprehensive series of tests was made. No effort was made to ascertain the mechanical efficiency of the individual units, such as motors, pumps, compressors, etc., since each of these had been tested at the various factories under the supervision of Government engineers, and it is understood that they met fully the specifications and the manufacturers' guarantees.

In preparing the plans and specifications for the plant consideration was given to the desirability of making frequent operating tests of the different portions of the plant, with the result that it was determined to provide in the permanent installation such gages and meters as would be necessary in obtaining the desired data.

The series of tests, or trial runs, on the air-lift installations is divided into two sets. In the first set, the power input to the compressor motors was obtained from readings of the recording dials of the watt-hour meters on the switchboard; the speeds of the motors and compressors by means of revolution and stroke counters; the rate of delivery of compressed air to the wells from readings of the scale of the manometer of the air meter; the air pressure from gages on the air receivers and at each well head; and the rate of delivery of water from the wells from the weir gage. In the second set of tests the power input to the com-

SUMMARY OF AIR-LIFTS TEST AT FORT BLISS, TEXAS

Test No.	Actual Air Delivered Cu.Ft. per Minute	Water Delivered per Minute Gal.	Water Delivered per Minute Cu.Ft.	Air Pressure at Receiver, Lb.	Pumping Head, Ft.	Water, Hp.	Air Hp. Isothermal	Input to Motors, Hp.	Efficiency, % Air-Lift	Efficiency, % Overall Wire-to-Water	Units Operating — Compressors	Units Operating — Wells
I. Input to motors from readings of watt-hour meters. Output from wells from weirs												
2	468.5	554	74.1	133	239	33.6	68.9	130.1	48.7	25.8	3 and 4	2 and 3
3	473.9	566	75.7	133	239	34.3	69.7	127.4	49.2	26.9	3 and 4	2 and 3
6	521.4	614	82.1	132	239	35.6	76.6	153.0	46.4	23.2	2 and 4	2 and 3
7	616.5	663	88.6	130	239	40.2	90.6	159.0	44.4	25.3	1 and 2	1 and 4
8	617.6	668	89.4	131	239	40.5	90.8	157.0	44.6	25.8	1 and 2	1 and 4
9	602.5	680	91.0	132	239	41.2	88.6	161.0	46.5	25.6	1 and 2	1 and 4
11	553.5	622	83.2	132	239	37.6	81.3	145.0	46.2	25.9	2 and 3	1 and 4
12	311.3	412	55.1	132	239	24.9	45.7	75.2	54.5	33.1	2	4
25	776.1	889	118.8	135	239	53.8	114.3	204.0	47.1	26.4	2, 3 and 4	1, 2 and 3
26	582.4	705	94.3	135	239	42.7	85.6	163.7	49.8	26.1	1 and 2	3 and 4
27	470.8	546	73.0	132	239	33.1	69.2	128.7	47.7	25.7	3 and 4	2 and 3
II. Input to motors from revolutions of disks of watt-hour meters. Output from wells measured volumetrically												
28	618.3	746	99.8	131	239	45.2	90.7	159.7	49.8	28.3	1 and 2	1 and 4
30	618.0	735	98.3	133	239	44.5	90.8	159.3	49.0	27.9	1 and 2	1 and 4
32	310.0	338	45.2	130	239	20.5	45.6	78.6	45.0	26.1	1	1
34	302.4	399	53.3	131	239	24.1	44.4	79.5	54.2	30.3	1	4
36	308.2	399	53.3	132	239	24.1	45.3	81.5	53.2	29.6	2	4
38	226.4	314	42.1	133	239	19.1	33.3	63.7	57.3	29.9	3	2
40	480.4	652	87.2	133	239	39.5	70.6	128.4	57.0	30.8	3 and 4	2 and 3
42	226.4	275	36.7	133	239	16.6	33.3	63.3	49.8	29.3	4	3

pressor motors was obtained by counting the number of revolutions of the rotating disks in the recording watt-hour meters, the rate of delivery of water from the wells from actual volumetric measurements by means of the surface reservoirs, and all other data as in the first set. The methods of obtaining the power input to the motors and the rate of delivery from the wells, as used in the second tests, are thought to be much more accurate than those used in previous tests, because unit rates are derived from totals for a given period of time rather than from direct observations.

The series of tests on the centrifugal pumping units is divided into three sets. In the first of these the power input to the motors driving the centrifugal pumps was obtained from readings of the dials of the recording watt-hour meters on the switchboard; the speed on the unit by means of a revolution counter; the rate of delivery of water and the total volume delivered during the test from the indicating and registering dials of the manometer of the venturi meter, and the head against which the pump was operating from the recording altitude gage. In the second set of tests, the power input to the motors was obtained as above described, and the total volume of water pumped during each test was measured volumetrically. In the third set, the power input to the motors was obtained by counting the revolutions of the rotating disks of the watt-hour meters, and all other required data were obtained as in the first set.

Results calculated from data obtained during the tests described are given in the accompanying table. The average efficiency of the air-lift for the first set of tests was 48.1 and for the second tests 51.9%. The average overall efficiency (wire to water) for the air-lift end of the plant for the first set of tests was 26.4% for the first and 28.66% for the second set of tests.

For the centrifugal pumping units the average overall efficiency (wire to water) for the first set is 43.6%, for the second 49.27% and for the third 55.93%. The results obtained in the first and second sets show overall efficiencies of the pumping units on the basis of useful work done. The power applied to the motors is consumed in actually pumping water against the pressure head in the distributing system. In the third set of tests, in which the pumps were throttled on the discharge side to give the desired rate of discharge, the statement of efficiencies is the relation between the power applied to the motors and the actual work done by the pump in forcing water through the partially closed gate valve in the discharge line and against the pressure head in the distributing system. The results in this set are interesting, therefore, only as indicating the actual overall efficiencies of the units.

The average power requirement for lifting water from the wells to the surface reservoirs is 2.77 kw.-hr. per 1000 gal. of water, and that for pumping the water from the surface reservoirs into the distributing system is 0.798 kw.-hr. per 1000 gal., under average working conditions of pressure and rate of delivery. At an average cost of 1.5c. per kilowatt-hour, the actual cost for power alone for delivering 1000 gal. of water into the distributing system is 5.34c. The cost for the pumping station crew, consisting of a chief engineer and one assistant engineer and one laborer on each of three daily shifts, and also including the cost of incidental supplies, such as lubricating oil and waste, is 1.66c. per 1000 gal., making the total actual cost 7c. per 1000 gal. The actual outlay of funds for this plant is $101,767, the original installation, including the two 10-in. wells, having cost $42,700 and the addition to the plant, including the two 12-in. wells, having cost $64,067. Interest at the rate of 4% upon the cost of the installation, and depreciation of equipment at the rate of 5%, are provided for by adding 2.63c. per 1000 gal., making the total cost for supplying water 9.63c. per 1000 gal., on the basis of a plant capacity of 1,000,000 gal. per day. Prior to the completion of the plant, water purchased from the El Paso Water Co. to supply the needs of Fort Bliss cost 20c. per 1000 gal. At an average daily demand of 1,000,000 gal., the annual saving to the Government effected by the operation of this plant is $37,850. If the plant capacity is taken as 1,500,000 gal. per day, which is its normal working capacity, providing for the shutting down of one compressor and one well, the total cost of supplying water is 8.21c. per 1000 gal., and the annual saving to the Government is $64,550. Taking the plant capacity as 2,000,000 gal. per day, which is the ultimate capacity of the present installation, the total cost per 1000 gal. is 6.74c., and the annual saving is $96,798

The original investigations and studies of the problem of providing an adequate water-supply for Fort Bliss, and all original designing in connection with the preparation of the plans for the project, were carried out during the years 1915-16 by Leonard S. Doten, who was at that time sanitary and hydraulic engineer in the

construction and repair division, Office of the Quartermaster General of the Army. The preparation of the plans for the addition to the plant in 1918 was also accomplished under his direction as advisory engineer on sanitation, Construction Division of the Army. The contractor for the original equipment installation was the Perry Electric Co., of Brooklyn, N. Y., and the general contractor for the addition to the plant was the Jennings Construction & Engineering Co., of El Paso, Tex., the drilling of the wells having been done by local contractors. The writer, at that time civil engineer for the construction and repair division, Office of the Quartermaster General of the Army, superintended the original installation and had charge of the preparation of plans for the addition to the plant, and conducted the tests described herein.

Centrifugal Pumps at the Chicago Water-Works Plants

Electric Power More Satisfactory Than Steam—Two 40,000,000-Gallon Pumps With 1100-Horsepower Motors Being Installed

EXTENSIVE use of centrifugal pumps for the Chicago water-works is due partly to the fact that the small floor area required enabled them to be placed in existing pumping stations which had no room for additional steam equipment, and partly to a movement for electrical operation of the pumping plants together with the low cost of an electrically operated centrifugal plant as compared with that of a steam-operated reciprocating plant. This movement has been backed by the Sanitary District of Chicago, in order to increase the city's consumption of current generated at the hydro-electric plant on the Drainage Canal. There are now 16 centrifugal pumps, with rated capacities ranging from 5,000,000 to 40,000,000 gal. daily, and six of these are electrically driven.

Steam-turbine centrifugal pumping units are reported to have given considerable trouble in operation, so that there is reluctance to install more machinery of this kind, at least where permanent service is required. The difficulties consist mainly in minor failures of turbine parts which necessitate shutting down the unit, but it has not been determined whether these are caused by unfamiliarity on the part of the operators or by defects in the machinery, or both combined. With motor-driven units there has not been much trouble. However, a flooding of the 22nd St. station, which caused the putting of all electrical units out of service for a considerable time, has indicated certain difficulties against which provision must be made.

The first centrifugal pump installation was made in 1910 at the 22nd St. pumping station. Additional capacity was needed to serve the stockyards district, but there was neither floor space nor boiler capacity for new steam units. The city engineer decided, therefore, to adopt motor-driven centrifugal pumps, which could be placed in the existing pump pit. The two pumps are each of 25,000,000-gal. capacity against 130-ft. head, directly connected to induction-synchronous motors having a rated capacity of 1000 brake-horsepower, 800 kva. The speed of pumps and motors is 514 r.p.m. This type of motor has the advantage of greater starting torque than a synchronous motor, while retaining the simple starting method of an induction motor. Current was furnished by the Sanitary District of Chicago, and was stepped down from 12,000 to 440 volts. These units have been in continuous service since 1911, pumping for much of the time at the rate of 20,000,000 to 30,000,000 gal. daily, or about 25% above the rated capacity. Their satisfactory service led to further use of the system.

Two steam turbine driven, direct-connected pumps of 20,000,000-gal. capacity, operating at 1500 r.p.m. were installed for temporary service at the Lake View pumping station in 1912. Four similar units of 25,000,000-gal. capacity, operating at 1550 r.p.m. were installed in 1913, one each for reserve at the 14th St., Harrison St., Central Park Ave. and Springfield Ave. stations. In 1914, two similar units for booster service were installed at the Roseland station, being of 5,000,000 gal. capacity and operating at 2750 revolutions per minute.

New equipment for the 68th St. station was needed at about this time, but as there was a probability of this station being abandoned in favor of a new location, it was not considered advisable to incur the heavy expense of new reciprocating pumps. To meet these conditions, the two 20,000,000-gal. turbine-driven pumps at the Lake View station were moved to 68th St. in 1914. Two 30,000,000-gal. units were installed at the latter station in 1916, but in this case reduction gears of the herring-bone type were used, the speeds being 3740 r.p.m. for the turbines and 720 r.p.m. for the pumps. It is stated that these units have given more trouble than any of the others, and new gears are now being placed. This station, with its four steam-driven centrifugal pumps, is still in service.

Motor-driven units have been adopted for all other installations, following the general type of the second plant at 22nd St. At the Jefferson Park station a 3,000,000-gal booster pump was installed in 1913, and two of 2,000,000 gal. in 1915. All had slip-ring induction motors, with speeds of 1140 r.p.m. for the smaller and 865 r.p.m. for the larger machines. These three booster machines were dismantled in 1918. Two 25,000,000-gal. pumps directly connected to 875-hp. induction motors, operating at 440 volts and with a speed of 720 r.p.m. were installed in the 22nd St. station in 1918, replacing some of the old steam pumps and supplementing the original electrical installation of 1911.

The largest centrifugal pumping units (which are not yet in service) are two 40,000,000-gal. machines, having a maximum rating of 50,000,000 gal., to replace two old steam pumps of 25,000,000-gal. combined capacity at the Chicago Ave. station, where there still remain three modern steam reciprocating pumps of 25,000,000 gal. each. The new centrifugal pumps will be directly connected to slip-ring induction motors of 1100 hp., operating at 2300 volts and with a speed of 720 r.p.m. An overall efficiency of 72.3% for pump and motor is required for this plant, which, it is expected, will be put in service in 1919.

All these installations of centrifugal pumps for main and supplementary units have been planned by and made under the direction of John Ericson, city engineer made under the direction of John Ericson, city engineer.

More Metering for Salt Lake City

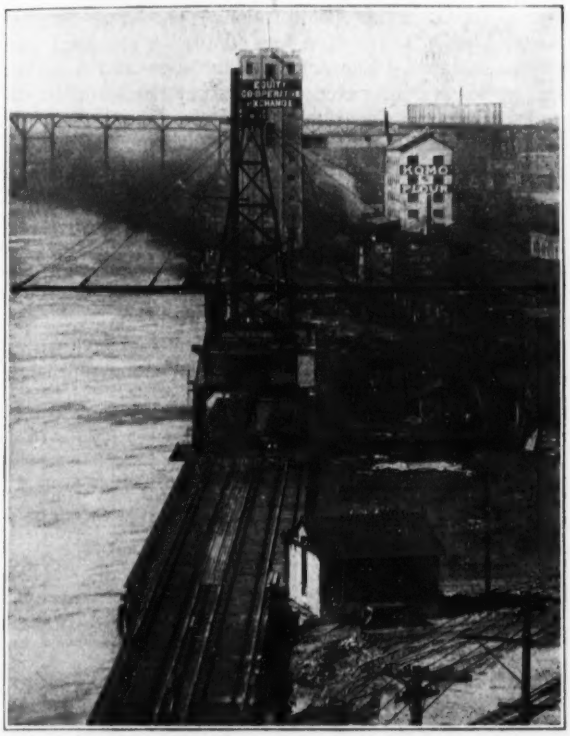
Under an amendment to a city ordinance of Salt Lake City, Utah, dating from the beginning of 1919, all new services are to be metered. At present about 25% of the services are fitted with meters. A water-waste survey is contemplated but has not been undertaken.

Municipal Freight-Handling Dock and Cranes at St. Paul

City Now Prepared To Convey Freight From the Mississippi River to Storage Yards, Trucks or Railroad Cars

ST. PAUL, Minn., has just completed a municipal river freight-handling terminal on the Mississippi at a cost of $71,800, and the city is now equipped to transfer river and land freight, if river haulage becomes popular. The terminal comprises main-line railroad tracks on a timber trestle paralleling the river, an adjacent storage yard, a large tower crane mainly to handle coal, and a locomotive crane for smaller loads.

The trestle is 800 ft. long and has two standard-gage tracks connected to the main-line railways. Straddling



CRANE WILL HANDLE RIVER FREIGHT AT ST. PAUL

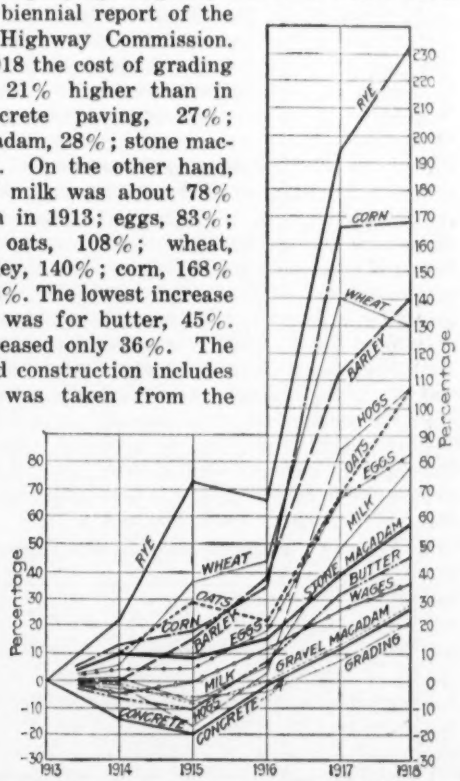
the tracks is the tower shown in the view, equipped with a 2-yd. clamshell bucket traveling on a boom which extends 70 ft. over the river and 85 ft. over the land. This tower is to be used exclusively for handling coal, sand, gravel, package freight, etc. The tower may load directly onto railway cars on the double tracks, to automobile trucks on the marginal way or dump on the storage platfrom. Parallel with the trestle the ground has been leveled off and filled in to provide storage for a width of 100 ft. Here 18,000 cu.yd. of earth fill was made, material being delivered free of charge from building excavations and other sources. The only expense connected with it is that of spreading and leveling.

The locomotive crane, which runs on the trestle tracks, has a 1½-yd. clamshell and a maximum working radius of 50 ft. The mean height of the river is only 10 ft. below the rail on the trestle, although in the view herewith the distance looks much greater.

The work was planned and built under the supervision of O. Claussen, chief engineer, and M. S. Grytbak, bridge engineer, of the city.

Comparatively Small Increase in Cost of Wisconsin Road Building

RELATIVELY low increase in cost of roads in Wisconsin during the war period, 1914-18, as compared with the increase in cost of farm produce, is shown by the accompanying diagram, which is taken from the fourth biennial report of the Wisconsin Highway Commission. Thus, in 1918 the cost of grading was about 21% higher than in 1913; concrete paving, 27%; gravel macadam, 28%; stone macadam, 58%. On the other hand, the cost of milk was about 78% higher than in 1913; eggs, 83%; hogs and oats, 108%; wheat, 130%; barley, 140%; corn, 168% and rye 233%. The lowest increase in produce was for butter, 45%. Wages increased only 36%. The cost of road construction includes labor and was taken from the



RELATION BETWEEN INCREASE IN COST OF WISCONSIN ROADS AND FARM PRODUCE

records of the commission. This chart shows that the farmer can build more road with a measure of produce than before the war.

100-Mile Motor-Truck Express Route

A 100-mile motor-truck express route is reported in operation between Portland and Salem, Ore., the round trip being 110 miles. Two 3½-ton trucks and one 2-ton truck are in use, the larger trucks making a round trip every day, while the two-ton truck is used on rush days and in picking up express packages in Portland. The freight rates range from 30 to 40c. per hundredweight, the trucks picking up and delivering all along the route. The line has had so much business that five tons have been carried every trip. Greater speed is expected when 20 miles of rather rough earth roads are improved. The express consists of taking milk, butter, eggs, veal, poultry, hogs, and vegetables to market, and merchandise on the return trip. E. B. Scott, whose father, Capt. Hugh B. Scott, ran the first light-draft steamer between Portland and Salem on the Willamette River, is behind the undertaking.

Study of Revenue From Sale of Water to Metered Domestic Consumer

New England Water-Works Association Form Based on Service and Output Charge Alone Rational and Equitable — Basing Revenue Estimates on Unregistered Water Leads to Error

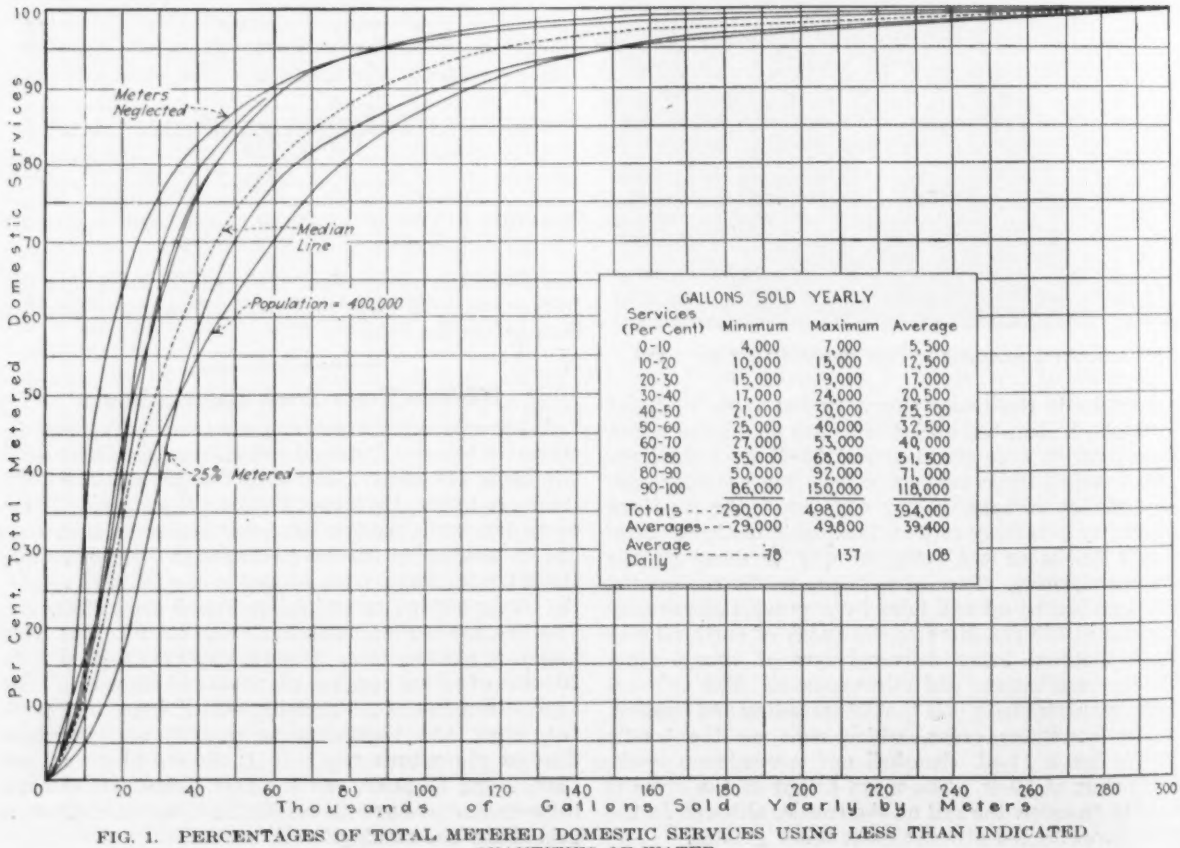
By Philip Burgess

Engineer, Columbus, Ohio, Before the Indiana Sanitary and Water-Supply Association

CONTROL of water rates charged, especially by private companies, is now largely in the hands of state commissions. It is the usual procedure, in adjusting water rates before the commissions, to determine, first, the cost of service, based in part on the reasonable return on the fair present value of the properties and in part on the operating and maintenance cost of the plant; and when the total cost of service is thus determined the schedule of rates is established so that the property will earn an amount at least equal to the total cost of the service rendered. It has been the writer's experience that during such proceedings it is customary to spend much time and effort in determining the value of the property and the cost of service but that little attention is given to the form of the schedule and the individual rates properly chargeable for the service. For this reason it is generally found that, after all the effort, the schedule of rates finally set up does not earn the amount which it properly should earn. This is particularly true when the schedule is changed from flat rates to metered service rates, and is attributable principally to lack of information relative to the amount and distribution of the water sold.

It is the writer's opinion that the determination of a schedule of fair water rates chargeable for metered service requires the setting up of a reasonable service charge, payable whether or not any water is delivered, and, in addition, a reasonable output charge for water actually consumed or sold by the meter. The most interesting and instructive discussions of the service charge are found in the reports of the committee on meter rates of the New England Water-Works Association and in some of the earlier reports of the Wisconsin Railroad Commission. The New England Water-Works Association has adopted a standard form of meter rates. The schedule includes also a service charge for a ⅝-in. meter. The output charge is divided under three classifications—domestic, intermediate and manufacturing—with limits of 75,000 and 750,000 gal. per quarter. Quoting from the *Journal* of this society (Vol. 30, No. 4, p. 469) the service charge for a ⅝-in. meter would be made of three parts, namely:

"(1) Ten per cent. of the average investment of the works in service pipe and meter; (2) one dollar per annum for reading meters, billing and collecting; (3) two dollars per annum for the probable value of unregistered water; for a domestic service charge with a ⅝-in. meter the ordinary service charge may properly



GALLONS SOLD YEARLY

Services (Per Cent)	Minimum	Maximum	Average
0-10	4,000	7,000	5,500
10-20	10,000	15,000	12,500
20-30	15,000	19,000	17,000
30-40	17,000	24,000	20,500
40-50	21,000	30,000	25,500
50-60	25,000	40,000	32,500
60-70	27,000	53,000	40,000
70-80	35,000	68,000	51,500
80-90	50,000	92,000	71,000
90-100	86,000	150,000	118,000
Totals	290,000	498,000	394,000
Averages	29,000	49,800	39,400
Average Daily	78	137	108

FIG. 1. PERCENTAGES OF TOTAL METERED DOMESTIC SERVICES USING LESS THAN INDICATED QUANTITIES OF WATER

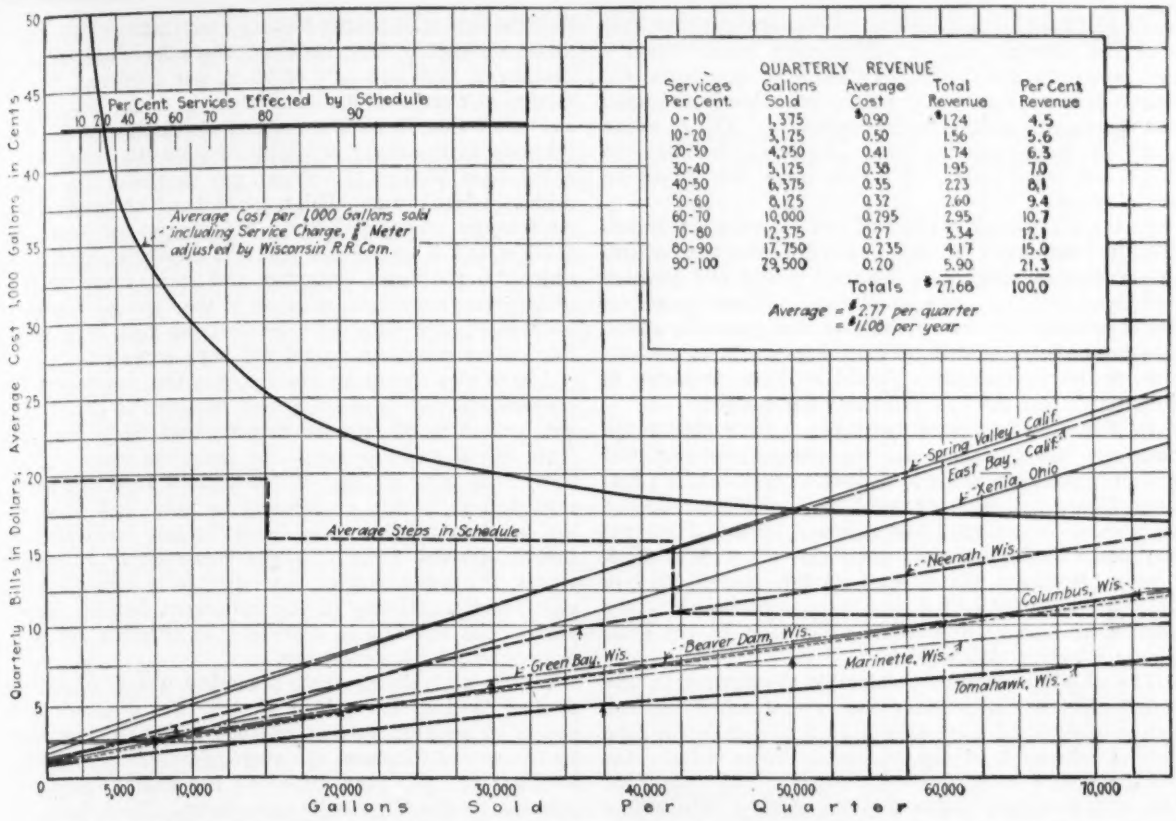

QUARTERLY REVENUE
Services Per Cent. | Gallons Sold | Average Cost | Total Revenue | Per Cent Revenue
0-10 | 1,375 | $0.90 | $1.24 | 4.5
10-20 | 3,125 | 0.50 | 1.56 | 5.6
20-30 | 4,250 | 0.41 | 1.74 | 6.3
30-40 | 5,125 | 0.38 | 1.95 | 7.0
40-50 | 6,375 | 0.35 | 2.23 | 8.1
50-60 | 8,125 | 0.32 | 2.60 | 9.4
60-70 | 10,000 | 0.295 | 2.95 | 10.7
70-80 | 12,375 | 0.27 | 3.34 | 12.1
80-90 | 17,750 | 0.235 | 4.17 | 15.0
90-100 | 29,500 | 0.20 | 5.90 | 21.3
Totals $27.68 100.0
Average = $2.77 per quarter = $11.06 per year
Per Cent Services Effected by Schedule
10 20 40 50 60 70 80 90
Average Cost per 1,000 Gallons sold including Service Charge, 3/4" Meter adjusted by Wisconsin R.R. Com.
Average Steps in Schedule
Spring Valley, Calif.
East Bay, Calif.
Xenia, Ohio
Neenah, Wis.
Columbus, Wis.
Beaver Dam, Wis.
Green Bay, Wis.
Marinette, Wis.
Tomahawk, Wis.
Quarterly Bills in Dollars; Average Cost 1,000 Gallons in Cents
0 5 10 15 20 25 30 35 40 45 50
5,000 10,000 20,000 30,000 40,000 50,000 60,000 70,000
Gallons Sold Per Quarter

FIG. 2. DOMESTIC METERED WATER REVENUES PER QUARTER AND AVERAGE COST PER 100 GALLONS

be $3, when the service and meter are paid for by the taker; $4 when the meter is furnished by the works; and $5 or $6 where both meter and service pipe are paid for by the works; the lower figure being used where the average cost of the service pipe is under $15 and the higher where it is greater than $15."

It is somewhat remarkable that the service charges determined by the committee of the New England Association and by the Wisconsin Railroad Commission are practically identical, for the amounts are determined in an entirely different manner, especially in regard to the third element which goes to make up the service charge. The New England society's committee determined as this third element the probable value of unregistered water. The Wisconsin Railroad Commission used elements similar to the first two elements contained in the service charge as developed by the committee, but as the third element of the service charge the commission included the capacity expense of the service rendered.

The writer believes that it is immaterial which method may be adopted to compute the service charge, provided that the output charge is figured consistently.

Many errors have been made in estimating revenue receivable under a meter rate, principally because of the fact that reliable information was not available as to the quantity of water sold under the schedule. This quantity frequently is determined by taking from the total output of the plant a certain allowance for unregistered water. In the writer's opinion such a method of computation frequently is subject to error, because of the fact that local conditions which are not determinable affect materially the percentage of unregistered water, which commissions are prone to underestimate. This is one of the fundamental reasons why rate schedules frequently do not develop the amount of the income which they properly should develop.

The more logical method of determining the quantity of water to be sold is, in the writer's opinion, to determine the quantity of water actually sold in similar communities—provided, of course, that reliable information be not available in regard to the plant in question. Unfortunately, however, but little accurate information is available to show the quantity and distribution of the water sold, particularly to domestic consumers. In Fig. 1 I have endeavored to show on several curves the quantity and distribution of water sold to domestic consumers, using the limitation of 75,000 gal. of water per quarter, specified in the schedule of the New England Water-Works Association. This will generally include from 90% to 95% of all services.

The curve, "Meters Neglected," indicates the sale of water by a plant serving about 9000 persons where the meters have been neglected for about 10 years and where the quantity of water sold obviously is much less than the quantity which reasonably should be sold. The curve, "Population 400,000," on the other side of the diagram, represents the distribution of water sold to a large city. It is obvious that the average quantity per consumer in a large city frequently may be more than that sold in a small city, because the water is cheaper in a large city and there is less incentive to conserve the supply; because frequently several families are supplied by the one service; and because there is a class of wealthy people residing in the large city which is not found in the small city. The curve, "25%

metered," also is distinctive as illustrating the fact that the average sale is considerably larger when a comparatively small part of the total consumers are metered, because naturally meters are placed first upon the services supplying large consumers. The "median line" represents approximately an average between the large and small cities, of which three are shown on the diagram.

In the right-hand portion of the diagram are shown the distributions of the sale to the different percentages of services supplied; also the total yearly and average daily quantities of water actually sold. These quantities are significant in view of the fact that generally about five persons are served by each meter. It is obvious that the actual quantity of water sold per consumer is very much less than is generally appreciated.

In Fig. 2 (see preceding page) I have shown the quarterly bills in dollars and the average cost per 1000 gal. in cents, chargeable to domestic services using less than 75,000 gal. per quarter. The schedules adopted were those as indicated and adjusted by the Wisconsin Railroad Commission, two schedules adopted in California, (*Jour.* Am. Water-Works Assoc., March, 1919, p. 37), after adjudication and one schedule recently adopted at Xenia, Ohio, after adjustment by the Ohio Public Utilities Commission.

The diagram shows considerable divergence in the actual cost of water under the several schedules, but on the other hand there is a marked agreement in four of the schedules of the Wisconsin commission. On the diagram I have shown the average costs per 1000 gal. sold, including the service charge of a ⅝-in. meter as adjusted by this commission. This rate varies from the service charge to about 17c. per 1000 gal. It is obvious that in order to get a similar apportionment or distribution of the cost of water service under a schedule containing a minimum charge, it is important that the first unit charge be very much higher than that usually adopted. For instance, the schedule at Xenia contains a first unit cost of 29.2c. per 1000 gal. and a minimum charge of $9.90. This rate is too low, with the result that there is a marked discrimination in the schedule in the favor of about 20% of the consumers, using from 5000 to 10,000 gal. per quarter. The commission wished to establish a schedule which would earn an average of approximately $15 yearly per domestic service, and it is obvious that the schedule selected is unjust to the small consumer and is in favor of the middle-class consumer, whereas if the form of schedule adopted by the Wisconsin commission had been used these discriminations would not have occurred.

I have also shown on the diagram the percentage of services affected by the different portions of the schedule, and it is of interest to note that 50% use less than 30,000 gal. per year. In the same way, I have shown the per cent. of revenue derived from the services, and it is also of interest to note that 50% of the services provide only approximately 30% of the income derived from domestic consumers. In other words, the lower part of the schedule is important as affecting the majority of the customers, but the upper part of the schedule is important as affecting the revenue earned by the company.

I have also shown that, assuming a sale of water similar to that determined on the first diagram and assuming an average cost of 1000 gal., as determined by the second diagram, the average income per service is about $11 per year, based on the average schedule adopted by the Wisconsin commission. This figure is of considerable interest and value in determining what may be reasonably earned by a plant where conditions are similar to those of the average plant above discussed. It is obvious that the expense of service established in California is about double the average

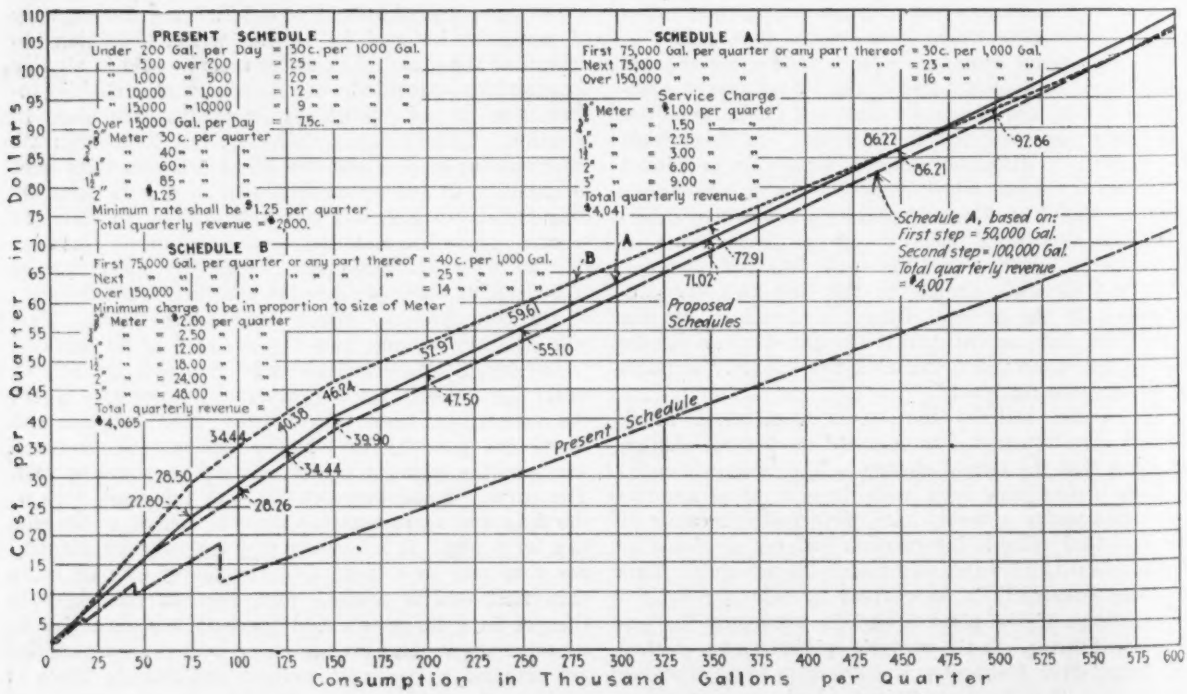

PRESENT SCHEDULE
Under 200 Gal. per Day = 30c. per 1000 Gal.
" 500 over 200 = 25 " " " "
" 1,000 " 500 = 20 " " " "
" 10,000 " 1,000 = 12 " " " "
" 15,000 " 10,000 = 9 " " " "
Over 15,000 Gal. per Day = 7.5c. " " "
⅝" Meter 30c. per quarter
¾" " 40 " " "
1" " 60 " " "
1½" " 85 " " "
2" " $1.25 " " "
Minimum rate shall be $1.25 per quarter
Total quarterly revenue = $2500.
SCHEDULE B
First 75,000 Gal. per quarter or any part thereof = 40c. per 1,000 Gal.
Next " " " " " " = 25 " " " "
Over 150,000 " " " " " = 14 " " " "
Minimum charge to be in proportion to size of Meter
⅝" Meter = $2.00 per quarter
¾" " = 2.50 " "
1" " = 12.00 " "
1½" " = 18.00 " "
2" " = 24.00 " "
3" " = 48.00 " "
Total quarterly revenue = $4,065
SCHEDULE A
First 75,000 Gal. per quarter or any part thereof = 30c. per 1,000 Gal.
Next 75,000 " " " " " " = 23 " " " "
Over 150,000 " " " " " = 16 " " " "
Service Charge
⅝" Meter = $1.00 per quarter
¾" " = 1.50 " "
1" " = 2.25 " "
1½" " = 3.00 " "
2" " = 6.00 " "
3" " = 9.00 " "
Total quarterly revenue = $4,041
Schedule A, based on: First step = 50,000 Gal. Second step = 100,000 Gal. Total quarterly revenue = $4,007
Proposed Schedules
Present Schedule
Cost per Quarter in Dollars
Consumption in Thousand Gallons per Quarter

FIG. 3. QUARTERLY BILLS FOR METERED WATER AT GENEVA, OHIO, UNDER PRESENT AND PROPOSED SCHEDULES

expense determined above. The expense at Xenia is about 50% greater than the average, and the form of the schedule could much more properly follow that of the New England committee or that adopted by the Wisconsin commission.

Fig. 3 (see preceding page) shows three rate schedules for a town of about 5000 population. Schedules A and B each are set up to earn practically the same revenue, but schedule A contains service and output charges, while schedule B contains output and minimum charges. Schedule B, containing a minimum charge, is discriminatory, and, in fact, it is practically impossible to make a schedule of this form which is fair to all classes of domestic consumers.

Schedule A should be improved by increasing the service charge and decreasing the first output charge, but there was serious local objection to increasing the cost of service to the small consumer. Schedule B could be improved by increasing the first output charge and by decreasing the quantity of water sold under this charge. Both of these changes would give better balanced schedules and would eliminate obvious discrimination against the middle class of consumer. The present schedule shown on the diagram is similar to many old "sawtooth" schedules in force, and is obviously very unsatisfactory and unfair. It tends to promote waste rather than to conserve the supply.

Interesting Conditions at Plant

Conditions at this plant were especially interesting, because investigation showed that only one-third of the entire output of the station was actually sold. One-third of the output was utilized in sewer flush tanks which were leaking badly and which required a large daily supply in order to make them operate. If rates were determined for this property in the usual manner, by subtracting, say, one-third of the total output as water unaccounted for, and by figuring the rate on the basis of selling two-thirds of the entire output, the actual revenue obtained would be just one-half of the computed revenue. Conditions at this plant are unusual but illustrate the principle which it is desired to emphasize—namely, that rates can be determined only on the basis of the quantity of water actually sold, regardless of the quantity which may be delivered by the system.

In conclusion, the writer believes that the New England form of schedule, with its service charge and an output charge, alone permits an equitable and rational basis of charge for water service. Its general adoption would provide valuable information relative to the actual cost and value of the water service rendered by different properties. Until some standard form of schedule is adopted comparative statistics of water rates will continue to be of little if any value, because the schedules are generally unfair and discriminatory in respect to some of the consumers supplied.

Oil in Chlorinated Water Causes Trouble

Water-supplies in the oil-producing districts of West Virginia are giving trouble, due to the combination of oil wastes with the chlorine. An investigation is being made under Mayo Tolman, chief engineer of the State Department of Health, Charleston, W. Va., to see what can be done to obviate this trouble. Pollution of water-supplies by oil wells is also a matter of investigation by the Kansas State Board of Health.

Handling Iron Ore at the Head of the Great Lakes

How Ore, of Many Different Compositions, From Hundreds of Mines, Is Delivered Rapidly To Boats in Required Analyses

By George H. Herrold
City Engineer's Department, St. Paul, Minn.

On June 20 those members of the American Society of Civil Engineers who will be in attendance at the annual convention in St. Paul and Minneapolis will start on an excursion to Duluth and the Missabe Range. This trip is made the occasion for the description here of one of the little-known details of operation of the iron field.—Editor.

Ore-dock design has been often treated in technical journals, but the system whereby this ore is taken from many mines in variegated composition and delivered to ore docks as required is not so well known.

The iron-ore output of the Lake Superior district was 61,156,732 tons for the fiscal year which ended June 30, 1918, and for Minnesota was 44,537,061 tons, or almost 75% of the total output of the Lake Superior district. Minnesota's output for the year which ended

DIGGING IRON ORE IN A MINNESOTA RANGE

June 30, 1915, was 22,000,000 tons, against a total iron-ore output in Germany in 1915 of 21,000,000 tons. On account of the richness of Minnesota ores, averaging 55% pure iron, it requires only 1.9 tons to produce a ton of pig iron, while the ores of Germany require 2.4 tons of ore. Four million tons of the Minnesota ore in 1918 came from state-owned lands, for which the state received a royalty of over $1,000,000.

This ore lies largely in three districts, known as the Vermillion, the Missabe and the Cuyuna Ranges. The Vermillion ore is all handled by the Duluth & Iron Range R.R. to its docks at Two Harbors on Lake Superior. The Missabe, by far the largest district, is tapped by four railroads, with docks at Duluth and Superior. The Cuyuna Range, the smallest and least developed, furnished 2,588,000 tons for the fiscal year which ended June 30, or an increase of 658,000 tons over the year previous. The haul to the Head of the Lakes is from 70 to 100 miles. The haul to St. Paul on the Mississippi River is 110 miles.

A view herewith shows a typical ore dock, the design of which is fairly well standardized. One of the largest of such docks, for instance, is 2304 ft. long, with 384 pockets of 300 tons, or six cars, capacity each. Its height is 80 ft. above the water surface and on its top are four parallel delivery tracks from end to end. The dock is partitioned along its center line with the pockets opening on either side. The cars, pockets and boat hatches are standardized. The ore car, 24 ft. in length,

DUMPING ORE ACCORDING TO ANALYZED COMPOSITION INTO BOATS AT DULUTH

has an unloading mouth of 8 ft., the pockets are 12 ft. wide, the boat hatches are 24-ft. centers and the ore chutes are 12-ft. centers. A boat can take ore only from alternate pockets without shifting its positions; a cargo for any given boat is therefore placed in alternate pockets. There are over 400 boats in the ore-carrying trade, with capacities of from 5000 to 13,500 tons each.

The ores of the different mines are divided into groups having certain outstanding characteristics, each group having a guaranteed or set analysis, and contracts are made on the basis of these groups. A mine may take out ore belonging to one of these groups, or its ore may have to be mixed with the ore from other mines or an ore of different grade from the same mine, to maintain a group analysis. From the mines, where cars are loaded in open pits or at shafts and switched to the holding yards, samples, usually in units of five cars, are taken to the laboratory, where they are crushed and tested, and a record is made of this unit, giving the car numbers, the name of the mine, the sample number and the analysis. In addition to the iron content, a determination is made of the phosphorus, silica, manganese, alumina, lime, magnesia and sulphur.

A "block" is the name given to a cargo of ore in process of formation, and is built up in a certain number of odd- or even-numbered alternate pockets at the dock. A "hold" is ore which cannot be assigned to any group or "block" because of being off grade, and is held in cars assigned to certain tracks or sections of track, according to grade, to be held for further disposition. "Blocks" and "holds" are designated by number, and no two numbers may be mixed without instructions from the laboratory. As each unit of five cars is weighed at the yard, its waybill receives its "block" number or "hold" number. If the unit belongs to a "block" it is switched to its proper track, and a train is soon made up, sent on its way to the dock, and unloaded. Here the actual tonnage and analysis are carried forward cumulatively until the "block" contains a mixture of ore, built up mathematically, which will have the proper group analysis. By this method units of five cars have been combined one with another and built up until the group analysis is reached. A boat takes, if possible, an entire "block" or all of two or three "blocks," in filling out cargo, for the mixture is mathematical, and a part of a "block" might run short or exceed the average analysis of the whole "block," and, while mixed mathematically, rather than actually, in the dock, it becomes actual after running through the chutes, being spread from near to far side, back and forth, to trim the boat. "Holds" are later ordered to the dock to raise or lower the analysis of a "block" which is running off grade.

All vessels must be loaded in the order of their arrival, and the tonnage and grades for each vessel must be given to the mines before they can begin to figure the "block." There are as many as 40 vessels on the list at one time, and, as many of these carry coal, the time required to unload must be taken into consideration in figuring the time they will arrive at the dock. A thorough knowledge of all lake boats, their capacities and draft and the conditions under which they can unload and load, is a part of the education needed by a dock superintendent or agent. As a road can handle, for instance, up to 125,000 ton in 24 hours to the yard, and the storage is 250,000 tons, and ore boats can take from 5000 to 13,500 tons of ore of any one of a possible 25 standard groups of grades of ore, the mines laboratory must block out the ore 24 to 48 hours in advance of the arrival of a boat, to insure the ore being ready for loading when the boat docks. Not only must ore be ready for loading when the boat docks at its assigned position at a certain dock under certain numbered pockets, but to the master of the vessel must be given the time required to load so he may know his leaving time. The average time of a boat at dock per one thousand tons loaded is one hour and 12 minutes, the average actual time loading is 38 minutes.

At the laboratory the unit is the pennyweight or gram. At the switching yard it is a unit of five cars of approximately 50 tons each, or 250 tons, and at the dock it is a "block," averaging 175 cars, or 8750 tons. Here is a mixing process carried on, on a mammoth scale, done accurately and expeditiously without delay to train or boats. The ores are sold under a guarantee to maintain within a fraction of 1% the chemical analysis of any group or grade. The operation requires skill, assurance and quick action, by men trained to keep accurate figures and accounts, and it is very rare to have serious mistakes occur in the handling of these immense quantities of ore.

Cedar Lake Landslide Damage Suits

The large slide that occurred on the hillside below the Cedar Lake reservoir of the Seattle water-works on Dec. 22, 1918, has led to the bringing of suits against the city for property damages. It is expected that hearings will be held during the summer.

Underwater Construction of Outshore Launching Ways

Speed and Economy of Work at Bristol Justified Choice of Diver Method in Place of Cofferdam Construction—Special Rig for Use in Placing Pile Caps

By E. D. Buel

Engineer for John Monks & Sons, Contractors, New York City

REMARKABLY low costs were recorded in the construction of the underwater or outshore portion of the shipways at the Government fabricated-ship yard at Bristol, Penn., operated by the Merchant Shipbuilding Corporation. The method employed here differed from that used by the contractors at the two other Government yards, at Hog Island, Penn., and Newark Bay, New Jersey.

Five contractors built the 50 shipways at Hog Island, and one contractor built the 28 at Newark Bay. Thus, seven contractors were engaged practically at the same time in constructing 90 shipways. Six of them elected to construct the outboard portion by the cofferdam method, while the contractor for the Bristol work decided to use an underwater method, employing divers. The marked predominance in favor of the cofferdam method caused some anxiety on the part of the engineers of the Emergency Fleet Corporation as to the wisdom of the choice of the Bristol contractor, with respect to economy and time of completion. On discussion of reasons, however, they allowed the contractor to proceed on his own lines. The ultimate success of the method fully justified its adoption.

Capped pile bents covered with a plank deck and carrying the longitudinal launching-way timbers constituted the work which was to be built. It is shown clearly in the drawing, Fig. 1, in inspecting which it is to be understood that the concrete-slab construction continues to the right, up the slope of the building berths. The slab construction extends from Sta. 0 at the head of the way to Sta. 3 + 10, while the timber-bent work extends from 3 + 10 to 4 + 84. There are 26 bents of 17 piles with 70-ft. caps 12 x 14, and 11 six-pile bents with 7-ft. caps 12 x 16.

There is a tidal range of 5.9 ft. at Bristol. In the spring of 1918, when this work was carried out, however, the water seldom went below El. 1.5, mean low water being 0. By taking advantage of low-water stages it was possible to cut off and cap the first seven bents. There remained in the 12 ways 4668 piles to cut off below water, 228 long caps, 264 short caps and about 350,000 ft.b.m. of decking to be placed under water.

For cutting off the piles a floating piledriver was fitted with a circular saw suspended on an arbor and driven by a 40-hp. motor, fed by current from the shipyard's power plant. The saw, shaft, arbor and necessary attachments were bought for about $450, and the motor was borrowed from the yard machine shop. The last pile in the shipways was driven Feb. 22, 1918, and pile cutting under water began Jan. 30, while the river was still frozen over. The piledriver was compelled to break its way through the ice, and in fact was hampered and impeded by floating ice throughout its period of service.

Although the machine was compelled to work from the outshore end and could operate only at water stages high enough to float it over the piles already cut, it proved economical and efficient in operation. The saw could work only three to four hours a day, but it cut through a pile in 40 sec.; a good day's work was 240 piles cut, and at this rate over 20 days were required to cut off all the piles. The pile cutting proved to be the simplest task of those involved in constructing the underwater bents.

By far the most difficult task was the staylathing or drawing into line of the 14 outshore bents of each shipway. This work had to be performed by the divers. The piles in each row were drawn into alignment by 6 x 12 yellow-pine clamps connected by specially designed clamp screws. These had to be applied below the elevation of cutoff, which was from 4 to 10 ft. below the surface of the water, depending upon the tide. The inner pile rows could not be staylathed, as the elevation of cutoff was too close to the river bottom to permit moving the piles; however, the alignment of the rows was excellent, the driving having been done with great care.

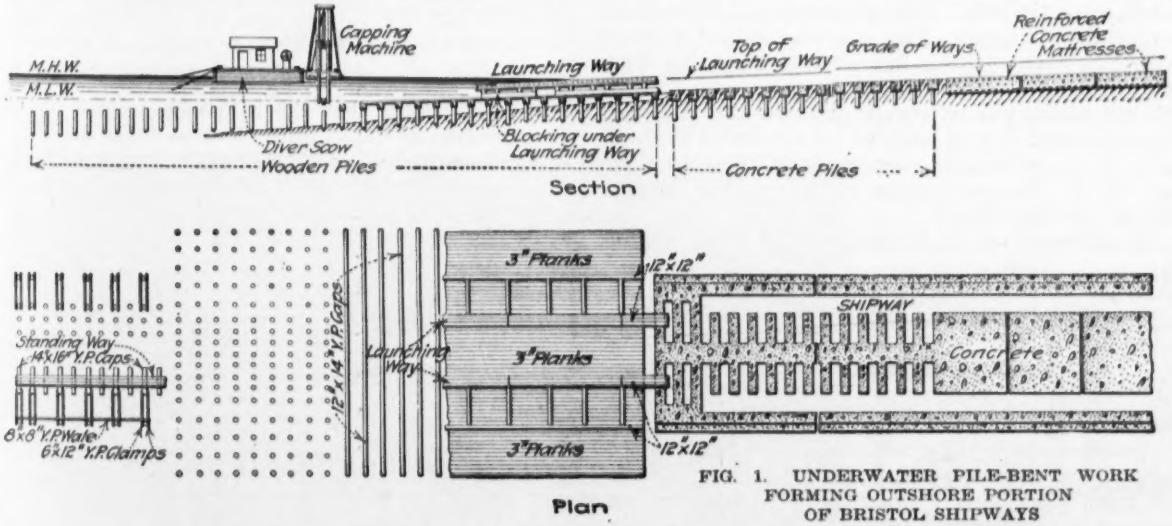


FIG. 1. UNDERWATER PILE-BENT WORK FORMING OUTSHORE PORTION OF BRISTOL SHIPWAYS

Several obstacles made the staylathing extremely difficult work: The rather shallow depth of water in which the divers were working, the ice conditions, and the fact that on account of the low temperature the divers had to wear heavy rubber mitts which hampered

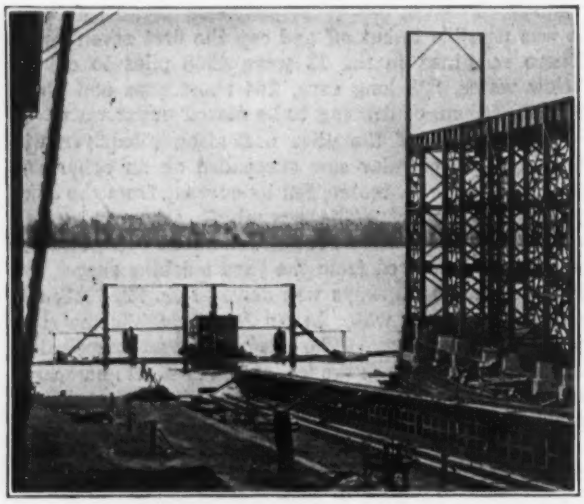


FIG. 2. PILE-CAPPING RIG IN WORKING POSTION OVER LAUNCHING WAYS

their work. A force of 12 divers was employed, the men working in pairs. Two divers averaged four short rows or one-half of a long row of staylathing in an eight-hour day. The total staylathing, therefore, required 210 diver-days, or 17.5 days' work for 12 divers.

In placing the 12 x 14 caps, which were to be fastened to the piles by 1-in. driftbolts 20 in. long, it was necessary to hold the caps down while lining them up and driving the bolts. Four pile-capping rigs were built to facilitate this work. They consisted of floating stages on which were erected gallows-frames supporting spuds weighted with railroad iron. As they were built of timber which was afterward used in the launching ways, the cost of each machine did not exceed $250. A view of one such rig in place over a pile bent is shown by Fig. 2. The construction of the machine is shown in the drawing, Fig. 3.

A full-length cap, 70 ft. long, of 12 x 14 timber, was framed on shore, floated into position, sunk by means of the capping machine, and then scribed by a diver, who marked the position of each bearing pile on the under side of the cap with a scribing knife. Then the cap was floated ashore and, elevations having previously been taken on each pile in the row, the cap was framed by dapping or shimming when necessary to bring it to an even bearing on all piles, and by bolting 6 x 12 fishplates on the sides in cases where one or more piles were slightly out of alignment, in order that the load should be distributed over the full bearing surface of each pile. Holes were then bored and the driftbolts driven through the caps. The cap was again floated to place and sunk on top of its bent. A diver working from each end would place a pipe over each driftbolt in succession, the pipe extending above the surface of the water, and dock builders working on the floating stage of the machine would drive the bolts home by means of weighted rods inserted in the pipes.

Each cap, after it was placed, was carefully inspected by a master diver to determine that it had a full bearing on each pile and that the drift-bolts were in each case driven home. Only very few caps had to be wedged up and reframed.

Two divers, assisted by six dock builders, would place three long caps or eight short caps in an eight-hour day. It is estimated that all the caps required 318 diver-days and 954 dock builder-days.

The decking was assembled on shore into platforms of suitable size to be sunk and spiked by the divers.

Assembling the total labor and plant cost of completing the outboard portion of the 12 shipways, the sum is found to be $33,919, itemized as follows:

COST OF LABOR AND PLANT, EXCLUDING MATERIAL AND PILEDRIVING, FOR OUTBOARD PORTION OF TWELVE SHIPWAYS AT BRISTOL

Divers, tenders and their equipment	$22 705
Dockbuilders assisting divers	7,824
Cutting off piles	1,890
Pile-capping and cutoff machines	1,500
Total	$33,919
Total per way	$ 2,826

It is estimated that the cofferdam method would have involved an expenditure of about $4920 per shipway for merely driving and pulling the steel-pile cofferdam, exclusive of the cost of piling, pumping and labor of cutting off and capping the bents. This applies to conditions at Bristol; possibly the design of the ship-

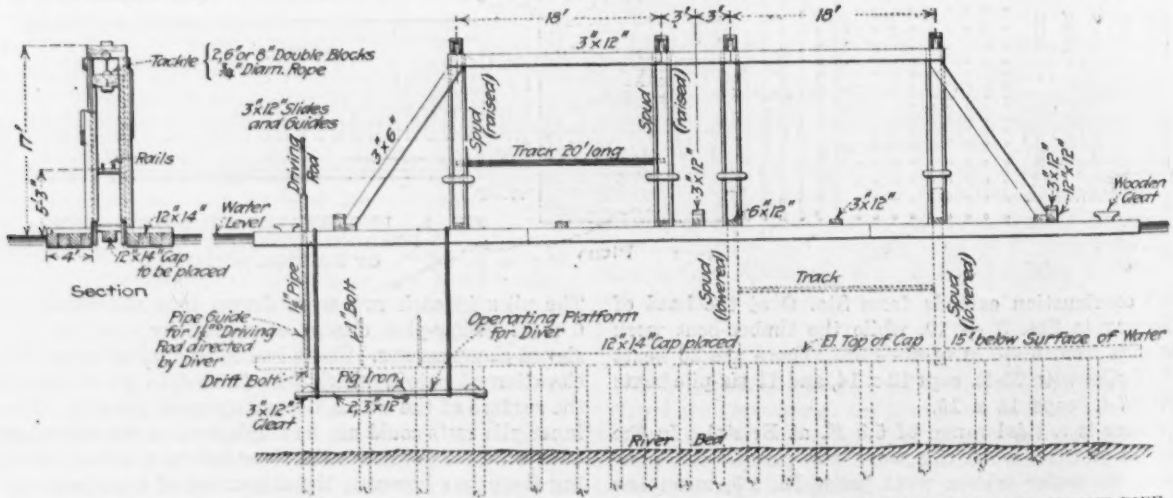


FIG. 3. PILE-CAPPING RIG WITH FLOATING PLATFORM, WEIGHTED SPUDS, DIVER'S PLATFORM AND DRIVE PIPE

ways at the other yards would not require as extensive a cofferdam, and in the absence of reliable figures on the cost elsewhere it is not intended in this discussion to draw any comparisons.

It is the purpose of the preceding to encourage engineers who have a prejudice against underwater construction to believe that this class of work can be handled economically, especially in these days when the wages of divers have not increased in proportion to the pay of other classes of labor. The capping machine is a very simple mechanism, as the photograph reproduced in Fig. 2 shows, and it proved very efficient.

By May 15, 1918, the work on all 12 shipways had been completed. John Monks & Sons of New York were the contractors. Though all of the work was carried on under the most adverse weather conditions, it is fair to summarize the whole case by saying that the final costs were at least 50% less than those which the cofferdam method would have involved, and the Bristol shipways were completed before those at the other two yards.

Council Bluffs Water Treatment in 1918

Substantially the same amount of money was spent for treating the Missouri River water by the water department of Council Bluffs, Iowa, in 1918, as in the previous year, despite the fact that chemicals cost slightly more per pound. The water is clarified by sedimentation, lime and alum coagulants, and sterilized by liquid chlorine. The average turbidity of the river water was 2380 p.p.m., of the settled water previous to coagulation, 1570, and of the final product, 11. Bacterial counts at the same points were 47,760, 1223 and 76. B. coli are always present in 1-cc. river samples, in 92% of the 1-cc. settled samples, and 6% of the 1-cc. treated samples. The 16 gr. per gallon of alum used cost $26.20 per ton, the 0.7 gr. per gallon of hydrated lime, $14.90 per ton, and the 0.258 p.p.m. of liquid chlorine cost 15c. per pound. The total cost of chemicals per 1,000,000 gal. was $4.06. S. L. Etnyre is superintendent.

Supporting Blast Furnace While Replacing Foundation

Well Braced Timber Trusses and Old Crane Girder Utilized—Cracked Brickwork Renewed by Concrete, Using Skip Bridge

By C. W. Lush
The Foundation Co., Limited, Montreal, Can.

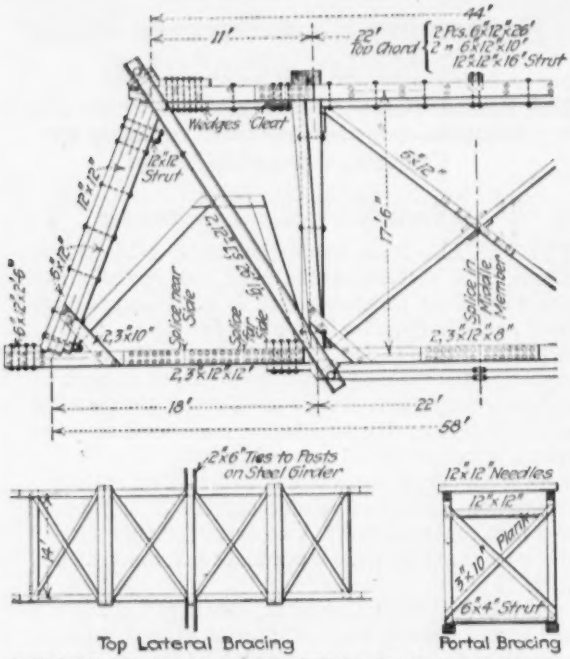
RENEWAL of the foundation under a blast furnace without disturbing the shell was recently accomplished for the Dominion Iron & Steel Co., at Sydney, N. S., which operates six blast furnaces. These are relined and remodeled in accordance with a schedule providing for the continuous operation of at least three, and generally four, furnaces. During the remodeling of No. 3 furnace the foundation was found to be badly split and veined with iron, and in order to provide permanent support it was decided to install an entirely new foundation instead of reinforcing the damaged one, as was first contemplated. A contract for this portion of the work was therefore made and work started early in July, 1918.

At this time the lining, bosh, hearth jacket and piping had been removed, and a choice of several methods of executing the work was afforded. The problem comprised the supporting of the furnace shell, bustle pipe and column heads, together with some loading from the bleeder pipes, reaction from the skip bridge and severe wind pressures from any direction of the compass. The contractor was required to maintain all existing structures at practically their original elevations.

Comparative studies of methods resulted in a decision to use two wooden trusses (with steel end diagonal web members) bearing on the side walls of the cast house and taking the load of the furnace at the mantle, as the main supports, while an old crane girder already on the site was utilized to take the wind load transverse to the trusses and to help support the bustle pipe. A general view of the shoring and of the principal physical features affecting the work is reproduced. Unique shoring details resulting in high salvage of material, and the adaptation of the construction details to existing conditions at the work, successfully solved the problems of high material costs and difficult labor situation obtaining at the site. The bolster castings and bearing pins used to distribute truss stresses at panel points were detailed to be available later for use as derrick foot blocks and gudgeon pins.

COMBINATION WOOD AND STEEL TRUSSES SUPPORT FURNACE TEMPORARILY

The two main trusses were first erected, and the load was thrown on them by jacking up under the end bearings. Next the old crane girder, which had previously been placed in position, received its portion of the load by tightening the wedges under the posts bearing on it. The brackets supporting



DETAILS OF COMBINATION TRUSS OF 58-FOOT SPAN

the bustle pipe were then removed from the furnace columns, and the pipe was supported on secondary bents in the main trusses. Finally, the furnace columns and base plates were removed, giving a comparatively clear working space for the necessary excavating.

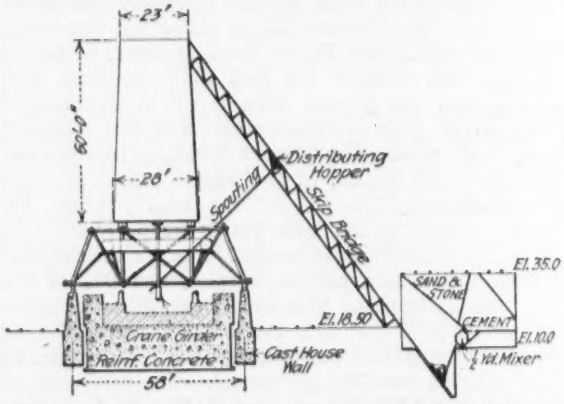
The excavation comprised about 1100 cu.yd. of brick and concrete in the old foundations, 500 cu.yd. of earthwork and a "salamander" weighing 100 tons embedded in the old foundation. The old foundation was broken up by light shots in holes from 2 to 5 ft. deep. One jackhamer working continuously was able to do the necessary drilling. A two-drum engine, through special rigging, operated two dirt buckets simultaneously, and, together with a five-ton crane, handled the material from the pit to three dirt hoppers emptying into cars alongside the cast house. The "salamander" was drilled preparatory to breaking it up, but as it was later found to be only 4 ft. deep it was dropped to the bottom of the excavation and buried under the new foundation, at a considerable saving in time, and without risk of accident to the shoring trusses.

The new foundation consisted of about 1500 cu.yd. of concrete, 140 tons of billet and rail reinforcing and 100M. brickwork. The alternate panels of rails were fabricated on the cast house floor during the excavating period and swung into place, and intermediate rails were erected immediately upon the completion of the concrete footing course.

The concrete for the work was handled by a plant made by adapting the idle coke bins and skip bridge of No. 3 furnace. The general features of this layout are shown in the diagram. Sand and stone were brought in cars on the ore tracks and dumped or unloaded by the ore bridge into the remodeled coke bins having a storage capacity of 125 tons of stone and 60 tons of sand. Cement was unloaded from the cars down a chute to a 250-bbl. storage platform level with the charging hopper. The mixed concrete was hauled up the skip bridge in a car improvised out of one of the dirt buckets and two pairs of spare lorry wheels; it was dumped into a distributor hopper and chuted into the foundations.

When the foundation was prepared for the column bases the columns were swung into place and hung from the mantle ring, the base plates were set under them and jacked up with two 100-ton jacks, and damp grout was rammed under the bases. After the grout was set the shoring screws were slacked off, the trusses were dismantled and the brackets were replaced under the bustle pipe. Finally, the protection ring of concrete was poured around the new hearth brickwork, this being completed Nov. 2, 1918.

The entire operation was successfully finished without any accidents whatsoever, under unusually adverse weather conditions including windstorms with recorded velocities as high as eighty miles an hour. The final settlement of the supported structures was between ¼ and ½ in., the furnace shell being maintained plumb at all times.



SKIP BRIDGE ADAPTED TO WORK OF PLACING CONCRETE

The work was designed and executed by the Foundation Co., Ltd., of Montreal, under the general direction of R. E. Chadwick, Eastern manager, with the writer as superintendent in charge of construction.

Street-Cleaning and Ash-Collection Costs

Unit costs of street cleaning and ash collection for 1915 to 1918, inclusive, for the City of Cincinnati, are published in the annual report of the Department of Street, Sewer and Catch-Basin Cleaning. In practically all the operations, the costs for the year 1918 were much higher than those for the previous years. The superintendent of this department is Fred Maag. The figures are given in the table below:

	1915		1916		1917		1918	
	Unit Cost	Unit Cost with Overhead	Unit Cost	Unit Cost with Overhead	Unit Cost	Unit Cost with Overhead	Unit Cost	Unit Cost with Overhead
Flushing, *squares	$0.137	$0.277	$0.119	$0.241	$0.121	$0.268	$0.120	$0.274
Street sweepings, cu.yd.	.242	.434	.270	.476	.286	.526	.332	.633
Ash collection, cu.yd.	.277	.465	.282	.468	.299	.515	.344	.613
White wings, 1,000 sq.yd.	.272	.312	.305	.352	.301	.247	.313	.360
Broom gang, *squares	.268	.324	.243	.295	.238	.282	.264	.305
Gutters, *squares	.132	.147	.136	.153	.144	.162	.138	.155
Gutters after flushing, *squares	.148	.164	.136	.151	.140	.157	.167	.187

* 1 square = 16,000 sq.ft. or 1 square = 400 lin. ft.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Contractor Actually Lowers Bid

Sir—I inclose a clipping which may be of interest to you as something rather unusual in contracting. The reduction in price mentioned will amount to about $1300.

JOSEPH KEMPER,
Utica, N. Y. City Engineer.

[The clipping to which reference is made is from the *Utica Press* of May 22, 1919. The following indicates the facts in the case:

A contractor who had put in a bid to do some paving, whose bid had been accepted and who had begun work, wrote to the city lowering his bid because he found he could do the work for less and still make a profit. This letter, from the Harry W. Roberts Co., continues as follows: "Certain changes which we have been able to effect in the cost put forward at the time the bids were prepared make it possible for us to authorize a reduction of 16c. per square yard on the pavement prices on both sections of Hart St., and on Gilbert St. In the event of our accomplishing reductions in the cost of any other local paving contract, we propose to offer a modification of contract terms corresponding to our cost saving."—EDITOR.]

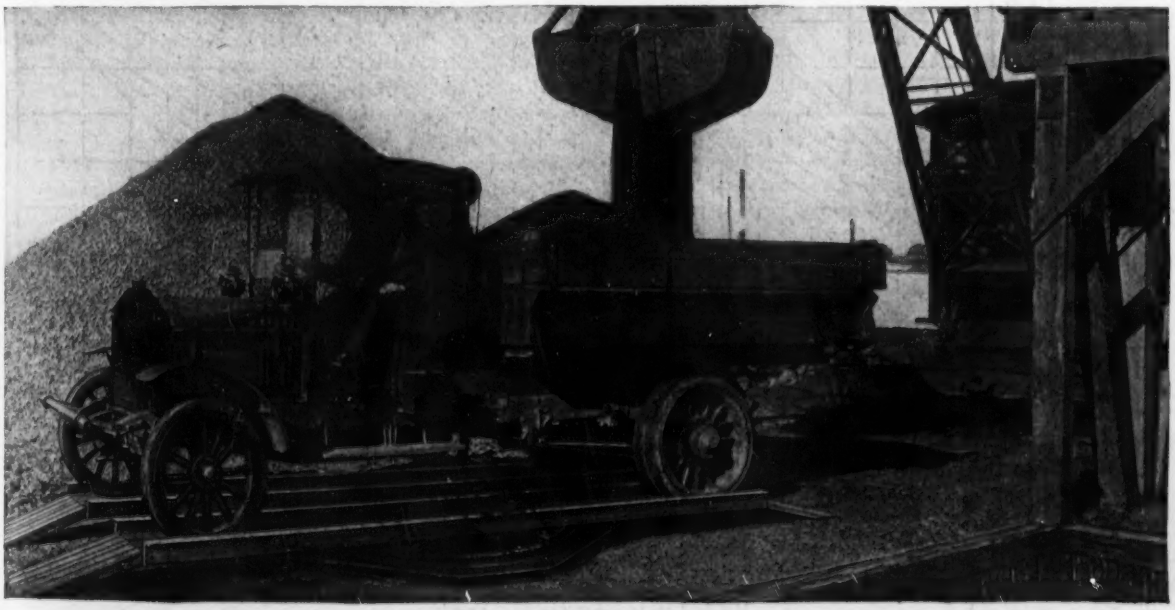
Portable Turntable for Motor Trucks

Sir—The letter of Fred C. Beam, of Lima, Ohio, published in your issue of May 1, 1919, p. 884, under the heading "Who Can Solve this Contractor's Problems?" particularly interests us. Mr. Beam suggests that a portable turntable suitable for use with motor trucks would fill a large need and appeal particularly to operators of motor trucks on construction work. For several months we have spent considerable time and money in the development of just such an equipment, and are now ready to supply a practical turntable of this kind.

Our turntable is the conception of a man who has devoted many years to supplying contractors' equipment and motor trucks for all classes of construction work. He has carefully studied the utility of motor trucks, particularly in connection with road construction. Several years ago he anticipated the need for some mechanical means of turning motor dump trucks when attempts were made to deposit sand and gravel on the subgrade of roads of insufficient width to permit trucks to turn around.

Another practical use for such a turntable is in connection with a revolving steam shovel. When it is set adjacent to and within range of the shovel dipper, a contractor can use motor trucks for hauling away from the shovel. Heretofore this has not been practical except under especially favorable conditions, owing to the difficulty in getting trucks in proper position and started on soft ground. In such circumstances much money has been spent to provide suitable places at which to turn trucks, to obviate the necessity of backing long distances at slow speed, taking undue chances of running over a cliff or into ditches, or getting into deep mud. Those who have not taken unusual precautions doubtless can recite sad tales of delays, pulling trucks out of mud holes and creek bottoms, with damage to subgrade, excessive repair and maintenance bills, excessive wear and tear on their expensive equipment, personal injuries, etc.

Portability on the job and strength successfully to handle loaded dump trucks up to the largest capacity of any make, are, of course, prime requisites for the desired turntable. We believe we have those points well provided for, yet have kept the total weight of our turntable low, nor does it set so high as to cause diffi-



PORTABLE TURNTABLE FOR TRUCKS IS MADE UP IN SECTIONS TO FACILITATE HANDLING

culty in getting on the platform. Our turntable is constructed to permit being pulled along the subgrade by truck or steam shovel or steam roller, without damage to subgrade or machinery. It is made up in sections to facilitate hauling it to the job, and is easily and quickly assembled. It can be furnished either hand- or power-operated.

This turntable will doubtless save much valuable space in material yards, docks, freight yards, etc. It will increase the utility of motor trucks by removing a very serious limitation heretofore encountered by almost all road contractors attempting to use motor dump trucks in the ever-increasing scope of our country's roadbuilding program.

M. D. RIKER,
Vice President, McKiernan-Terry Drill Company.
New York City.

Chart for Solution of Manning Formula

Sir—The accompanying chart for the solution of the Manning formula for the flow of water in pipes or open channels has been so useful to me that it may prove useful to others. It is relatively simple to work with, gives results without bad angles of intersection, even in the extreme ranges, and covers all probable ranges of the four variables. The percentage of accuracy is the same throughout the entire range. My results indicate that the error should be less than 2% in determinations of velocity, or 4% in slope determinations.

Manning's formula, which gives relatively satisfactory results for channels of small or moderate size, and with usual slopes is

$$v = \frac{1.49}{n} m^{\frac{2}{3}} s^{\frac{1}{2}}$$

in which v is the mean velocity of flow in a pipe or open channel, m is the hydraulic radius of channel, s is the slope of the hydraulic gradient, and n the coefficient of roughness, taken to be identical with Kutter's n. Suggested by Robert Manning in 1895, it was published in 1915 in Parker's "The Control of Water."

An incidental advantage in this chart lies in the ease with which different slopes or roughness factors may be compared, and the effect of changes visualized. Thus, if hydraulic radius and roughness factor are known, a horizontal pencil line drawn through their intersection on the chart crosses each slope line vertically below the corresponding mean velocity.

In case it is desired to redraw the chart for practical use, the following instructions may be of service:

The vertical lines form a logarithmic scale, three times repeated, and serve both for hydraulic radius and mean velocity. The horizontal lines are uniformly spaced, and the "slope" lines, s, lie at an angle of 45° to the horizontal. The line $s = 0.01$ starts at the top border line at mean velocity = 1 ft. per second, and $s = 0.0001$ at mean velocity = 0.1 ft. per second. The other slope lines divide the distance between these two into a logarithmic scale, twice repeated, so that the unit lengths of this scale are just half of the main scale.

The roughness lines lie at a slope of three horizontal

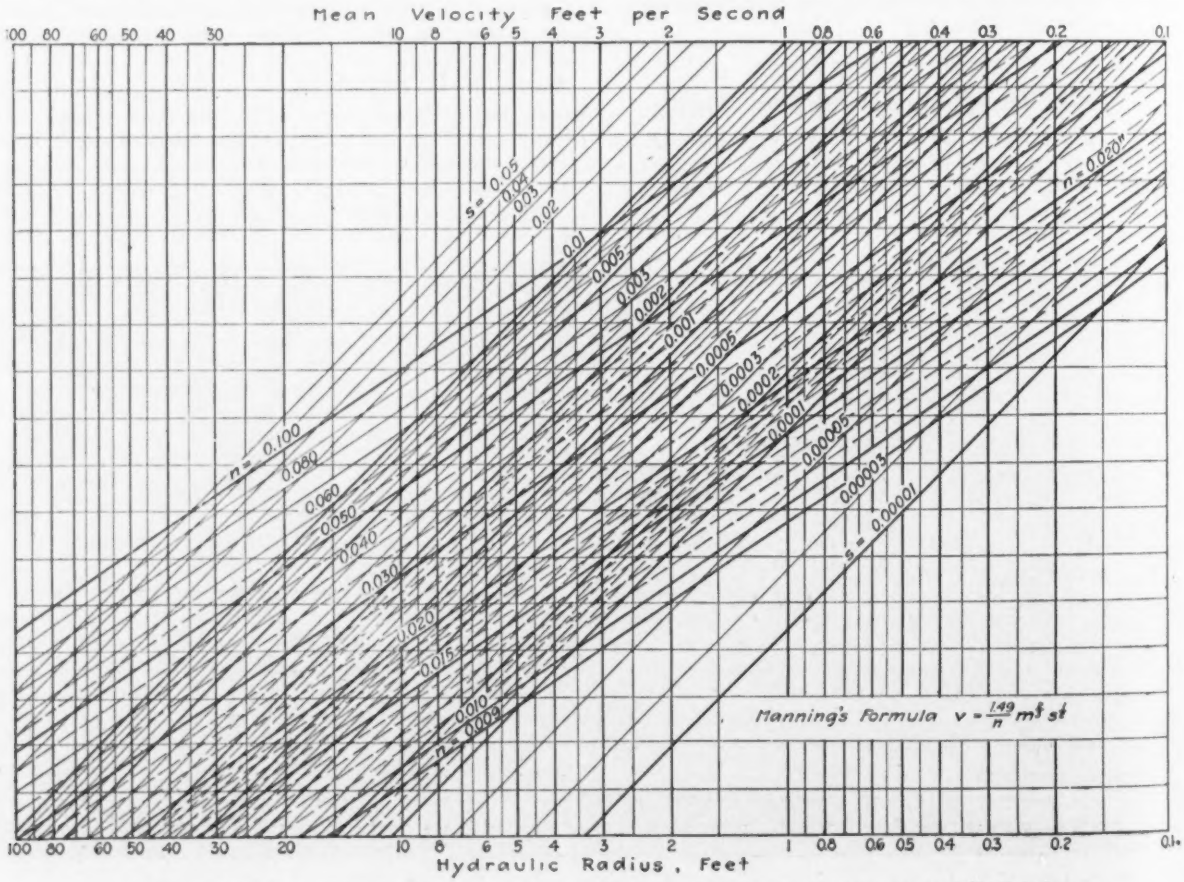


CHART FOR SOLUTION OF MANNING FORMULA FOR FLOW OF WATER IN PIPES

to two vertical, all parallel. They also form a logarithmic scale, and the unit length of this scale, along a vertical line (not at right angles to the lines) is the same as the unit length of the hydraulic-radius or mean-velocity scales. Slope line $s = 0.0001$ intersects mean velocity = 1 ft. per second at roughness factor line $n = 0.0149$ (not drawn). This fixes the position of the roughness factor scale.

MORTIMER F. SAYRE,
Assistant Professor of Applied Mechanics, Union College.
Schenectady, N. Y.

Plumbers to Be Called Sanitary Engineers?

Sir—Several articles have appeared in *Engineering News-Record* in the past year or so on the subject of what constitutes an engineer. The following is an article which appears in the May issue of the *Valve World*, published by the Crane Co., of Chicago. It is entitled "Why 'Plumber'?"

"Among other features of reconstruction and readjustment we may mention a renaming of the plumber. Whether there is anything in a name or not, we are of the opinion that every plumber in the United States would hold his head a trifle higher and put his trade or his business on a more elevated plane if he were known as a sanitary engineer.

"Let us proceed forthwith to banish the term plumber. It is obsolete or should be. It is lacking in scope. It never can be purged of certain associations that have not tended to give it dignity.

"The *Valve World* will be pleased to attend the obsequies of the term 'plumber' at any time and to hail with hearty acclaim the 'sanitary engineer.' We await only official announcement of the funeral."

The time has surely come when our engineering societies should use their influence to protect the name "engineer."

STEWART T. SMITH.
New York City.

Origin of Government Specification for Manila Rope

Sir—In connection with the publication of an abstract of "United States Government Standard Specifications for Manila Rope, adopted Apr. 4, 1918," in your issue of May 15, p. 958, your attention is directed to supplementary information contained in a bureau letter of Apr. 24, 1919, with which mimeographed copies of these specifications were transmitted as an inclosure. It is regretted that no reference was made to the circumstances under which these specifications were adopted, inasmuch as the published article gives the erroneous impression that the bureau is solely responsible for their development. In reality, the joint conference of cordage manufacturers and Government representatives, held Apr. 4, 1918, was the final session of a series of such conferences extending over several months. The conferences were initiated by the Bureau of Construction and Repair of the Navy Department. F. A. Jenks, of the Plymouth Cordage Co., was the conference chairman, and Prof. J. H. Nelson of this bureau's staff served as secretary.

The conferences revised and rewrote an initial tentative draft of manila-rope specifications prepared at this bureau in the autumn of 1917. The initial draft consisted in general of a combination of the diverse specifications at that time in use by various bureaus of the War and Navy Departments, the Panama Canal and the United States Shipping Board. In addition to the use of such specifications, advantage was taken of the results of bureau research into the determination of oil content, the detection of the presence of nonmanila fiber, and the determination of weight, breaking strength and size of rope. The Department of Agriculture furnished the information on which the fiber requirements were based.

An attempt was made to circulate the invitation, to participate in the conference, as widely as possible among the manufacturers of manila rope. The rope manufacturers are chiefly responsible for the final form in which these specifications appear, although their adoption was indorsed by representatives of the Government departments mentioned above. The departments have subsequently used them as the basis for Government purchases of rope.

S. W. STRATTON,
Director, Bureau of Standards.
Washington, D. C.

Subdrainage for Country Highways

Sir—Replying to your remarks on my letter in *Engineering News-Record* of May 29, 1919, p. 1080, discussing underdrainage of roads, I wish to thank you for the comment, as a discussion of this question will bring it more directly to the notice of those who are confronted with the necessity of providing a stable roadbed for highways of any kind. In this section of the country many highways are being reconstructed and changed from gravel or macadam to hard surface, long before the bonds issued for first construction have matured.

As to the question whether my letter pertains to "macadam and earth roads almost entirely," I must say that the matter of underdrainage is of the soil. The question of the metal or surfacing of the highway is wholly immaterial; the object is to obtain a subgrade which will most nearly remain in a uniformly stable condition throughout the year.

In the first place, the subgrade for any class of highway must be dry and settled, to permit proper construction. Then the parallel underdrains along each edge of the metal will prevent excess water from reaching the subgrade after construction, and no water can reach it from above because of the hard surface.

Subdrainage for highways is but an application of the principles of drainage for agricultural purposes. The object of agricultural drainage is to remove excess moisture, place the soil in proper condition for the propagation of crops, and prevent heaving of the soil.

If underdrains will prevent heaving in cultivated lands, will they not prevent it in the same soil under a hard-surface road?

I believe that the underdrain will work better if the natural soil, well tamped, is used as backfilling, instead of stone, gravel, cinders or material of like nature which will permit the air current from the tile to escape more directly upward, while to get the full beneficial effect it should also penetrate laterally.

As to tile filling with roots, in our city we have had great trouble with the roots of Carolina poplars finding small cracks in the joints of pipe sewers and filling the pipes. But we have waged a war on trees of that nature and now have very little trouble.

M. H. DOWNEY.
Anderson, Ind.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Lowering 240 Feet of Submerged Pipe From Scow in One Section

IN LAYING a submerged 16-in. cast-iron water main across the city ship canal at Buffalo, N. Y., the method adopted was to lower it slowly into a dredged trench, from the side of a scow fitted with A-frames for chain falls. The pipes averaged 155 lb. per foot and had bell and spigot ends for flexible joints of the Metropolitan type, in which the lead is retained in the bell when the pipe is deflected. Lengths of 12 ft. were used on the bottom, while 6-ft. lengths were used at the shore ends to give greater flexibility. At each end provision was made for connection with joints of the standard type. At the crossing the canal is 220 ft. wide, with sloping sides; the channel is 100 ft. wide, with 23 ft. of water. A trench 5 ft. wide was dredged to a depth of 30 ft. below water level in the channel, decreasing toward the banks. The total length of the submerged line was 240 feet.

For assembling the pipes, a deck scow 26 x 90 ft. was used, the whole line being made up into three sections. After each joint was calked the pipe was moved within the limits of deflection before another was added. For lowering the pipe line into place a derrick scow and a piledriver were used, the latter being lashed to the bow of the scow. Six A-frames were erected along one side of the deck of this scow, carrying chain falls for suspending the pipe line. There were three lines also from the head of the piledriver. The deck scow, with the sections of pipe assembled, was moved alongside the derrick scow, and the section for the east bank was picked up and suspended from the chain falls on the A-frames. Then the scow was moved forward and the section for the bottom was similarly suspended, the joint between the two sections being then poured and calked. This joint was deflected by lifting with the derrick leg. The section to be laid on the west bank was next added, this being suspended from the three lines on the piledriver.

When the line was ready for submerging, the derrick scow and the piledriver were swung across the channel in line with the trench, with the stern of the derrick against the east bank. The entire line was then lowered slowly until the east end rested on a pile cradle, where it was securely anchored. Then eight leads of 1¼-in. manila rope were attached to the derrick scow, and the load was transferred from the chain falls to these lines, the deck ends of which lines were fastened to snubbing posts.

All the lines were then slacked off gradually, allowing the pipe line to sink slowly to its bed. Guides attached to the pipes indicated the various depths as the pipe sank.

Only 3½ hours were required for the whole operation, from the time when the scows were swung across the channel until the pipe rested on its bed; this was the total interruption to navigation. A diver sent down to hammer up all joints found the pipe and joints in good condition. When the shore ends were connected the line was tested by means of a meter. A small leakage was shown at first, but this gradually decreased until it became negligible.

This work was done in November, 1918, at Hamburg turnpike, for the purpose of providing fire protection to an isolated section of the City of Buffalo. It was done under the direction of George C. Andrews, water commissioner.

Other Articles in This Issue of Interest to Contractors:

Highway Design and Construction Papers Read Before Canadian Road Congress Page 1100

Underwater Construction of Outshore Launching Ways Page 1121

Supporting Blast Furnace While Replacing Foundation Page 1123

Portable Turntable for Motor Trucks (Letter) Page 1125

Bell Slots in Trench Sides Made Use of Narrow Elevator Possible

BELL holes or slots cut in the sides of a trench permitted the laying of nearly two miles of 36-in. pipe in a trench dug by an excavator which could not cut to the full width desired. This work was done by the Bureau of Water at Buffalo, N. Y., under the direction of George C. Andrews, water commissioner, in 1918, to give additional supply to the American Brass Co. and to provide for future needs of the northwestern section of the city.

A trenching machine and power backfiller that were owned by the bureau facilitated the work and reduced its cost on a stretch of 3100 ft. through the grounds of the New York State Hospital, but for the remainder of the distance the work was in paved streets where the machine could not be used.

A 45-in. trench was the maximum that could be cut with the machine, while a 60-in. width was used on that part of the work done by hand. As the narrow width was not sufficient for lowering the pipe into place and at the same time bracing the sides of the trench at the top to protect the pipelaying operations, the following plan was adopted:

Each side of the trench was cut down about 18 in. for a distance of 6 in. back at the top, allowing room for 4 in. of bracing on each side and giving the necessary clearance for the bells of the pipes. Bell holes were then cut out of the side of the trench by hand. The machine cut a trench 7 ft. deep instead of the usual 6½ ft., and 6 in. of blocking was used under the pipe to eliminate

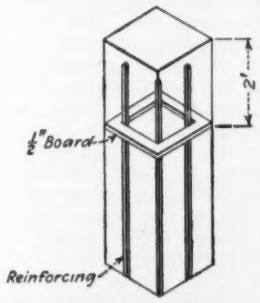
the digging of bell holes in the bottom. This method proved satisfactory and speeded up the work.

Hand labor was employed in handling the pipe, and with a gang of 30 men the excavation and pipelaying proceeded at the rate of about 180 ft. a day. The trenching machine was never worked for more than one-half day, and was kept about two days ahead of the pipelayers. The power backfiller, operated by one man, backfilled the entire trench, with a material saving of labor and time. The greatest number of pipes laid in a single day was 22. The cost of labor for that part of the line done by machine was $4.30 per linear foot, while for the part done by hand labor it was $8. The total cost per foot for the entire line was $23. In comparing the costs of machine and hand labor on this line it should be noted that hand labor was used on paved streets; nevertheless, a great saving is shown by the use of the trenching machine and backfiller.

Two gangs on the work done by hand comprised about 150 men who excavated a 60-in. trench 6½ ft. deep, with bell holes in the bottom, laid the pipe and backfilled, at the rate of 120 lin.ft. per 10-hour day. The pipe was lowered by chain falls and tripod.

Wood Diagram Leaves Top for Concrete Pile After Driving

TO PROVIDE a finished surface at the top of a concrete pile which may be battered during the driving, a special type of joint was used on the Norfolk Army base built during the war. This consisted of a wood diaphragm, made up of ½-in. boards, encircling the reinforcing rods about 2 ft. from the top of the pile, as shown in the sketch. If the hammer spalled the concrete at the top, light charges of powder set just above the diaphragm readily loosened the upper section, permitting its removal and leaving a smooth top, below which no damage extended.



WOOD DIAPHRAGM MAKES JOINT AT CONCRETE PILE TOP

The method was devised by the Raymond Concrete Pile Co., which made the precast piles used in the work.

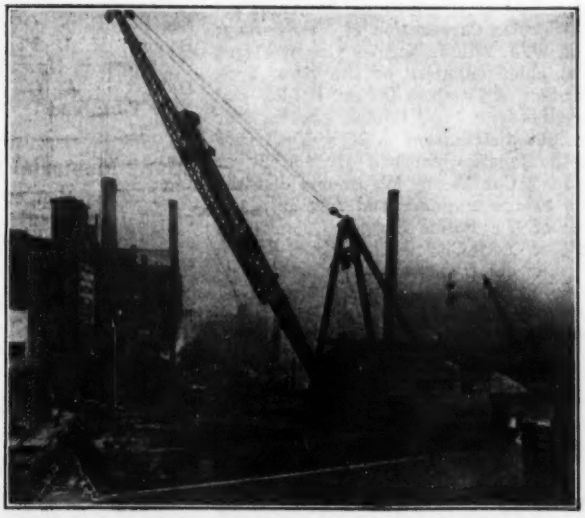
Dragline Embarked by Grounding Scow

A DRAGLINE excavator weighing over 200 tons was transferred from a river bank onto a scow by the simple expedient, shown by the accompanying illustration, of grounding the scow in a specially excavated shallow slip dredged into the river bank. The dragline dug the slip and dragged its bottom smooth and level, after which the scow was sunk by letting water into it. The shore tracks for the dragline were then extended onto the scow, and the heavy machine was moved into position by its own power. When it was in position the wheels and the underbody were removed, and the dragline was lowered onto and fastened to I-beams on timber sills. The operation was performed at Dayton, Ohio, on the Dayton channel improvement of the Miami Conservancy District. Arthur E. Morgan is chief engineer. Charles H. Paul is assistant chief engineer and C. H. Locher is construction manager.

TRANSFERRING 200-TON DRAGLINE EXCAVATOR TO SCOW GROUNDED ON RIVER BOTTOM

Lengthen Derrick Boom by Second Boom

TO HANDLE 60-ft. 10-ton steel anchor columns in a vertical position, so as to lower them through the pockets of cofferdam bracing, a boom of extra length and strength was required for the steel floating derrick used by the Great Lakes Dredge & Dock Co. at the new Michigan Ave. bridge in Chicago. To secure the necessary length of about 95 ft., a similar but lighter boom for this same derrick was spliced to the main boom as shown in the accompanying view. It was attached by long bolts through timber cross-pieces.



TWO DERRICK BOOMS ARE SPLICED TO MAKE ONE LONG BOOM

The columns handled in this way are embedded in the anchor piers and carry the girders which take the uplift due to the leaves of the bascule bridge.

NEWS OF THE WEEK

New York, June 5, 1919

C. M. Holland and Board To Build Hudson Tunnel

Tunnel Engineer Now In Field Charge of East River Work Selected as Chief Engineer

On June 3 the Joint Interstate Bridge and Tunnel Commissions of New York and New Jersey made the final selection of the engineers who are to direct the construction of the highway tunnel under the Hudson River recently authorized by the two states. Clifford M. Holland, now tunnel engineer of the Public Service Commission (New York City), in charge of rapid-transit tunnel construction under the East River, was chosen as chief engineer. At the same time an advisory board of engineers was created, to guide in the decision on the layer problems involved.

The advisory board is composed of J. Vipond Davies, of the consulting engineering firm of Jacobs & Davies, engineers of the Pennsylvania R. R. Hudson River tunnels and engineers and constructors of the Hudson & Manhattan tunnel system; Prof. William H. Burr, former member of a board of engineers which studied the feasibility of a Hudson River tunnel for the Public Service Corporation of New Jersey; Col. W. J. Wilgus, former vice-president and chief engineer of the New York Central & Hudson River R. R., and originator of a tunnel project for freight distribution in New York City in conjunction with a Hudson River tunnel; Col. Henry W. Hodge, consulting bridge engineer and former member of the Public Service Commission of New York City; Maj. John A. Bensel, former chief engineer of the Department of Docks and Ferries, New York City; and E. A. Byrne, chief engineer of the Department of Plant and Structures (Bridges and Ferries), New York City. Mr. Byrne, it is reported, will serve without compensation, while the other members of the board will receive annual retainers of $10,000.

Advisory Committee on Shipping Law Revision Appointed

Revision of the navigation laws in regard to measurement of vessels, standardization, inspection of construction, and other matters affecting the competition of American ships with those of other countries, is to be studied for the Shipping Board by a committee just appointed. The results of the committee's work will be the basis of recommendations to Congress for appropriate legislation. The committee is composed of P. A. S. Franklin, president of the International Mercantile Marine Co.; J. P. Kirlin, admiralty lawyer, New York; H. F. Alexander, ship owner, Seattle; E. E. O'Donnell, ship owner, Boston; H. L. Ferguson, president of the Newport News Shipbuilding & Dry Dock Co.; A. G. Smith, ship owner, New York, and D. T. Warden.

Employment Bureaus

Engineering Societies' Employment Bureau, 29 W. 39th St., New York City.

American Association of Engineers, 29 S. La Salle St., Chicago. Service to members only, but Army or Navy Engineers in uniform who are eligible to certified membership may join without payment of entrance fees or dues while in uniform and for six months after discharge.

Engineers' Service Bureau, 57 Post St., San Francisco. Only applications by mail or wire will be considered.

Professional and Special Section, United States Employment Service, 469 Fifth Ave., New York City.

Reëmployment Committee of New York City for Soldiers, Sailors and Marines, 233 Broadway, New York City.

Many Memorial Day Launchings

In celebration of Memorial Day an unusual number of launchings was carried out in the various shipyards of the country on May 30. The most notable performances were made at the two Government fabricated shipyards at Hog Island, Penn., and Newark, N. J. Five 7800-ton ships were launched at Hog Island. The Submarine Boat Corporation, at Newark, launched three 5000-ton vessels; with these it has put into the water 52 hulls since its maiden launching on May 30, 1918.

Elevated Railway Extension, New York City, Begun

Construction of the elevated portion of the Pelham Bay Park branch, Lexington Ave. subway, New York City, began during the past week under a contract executed between the Public Service Commission and the Terry & Tench Co., Inc., for $586,700. The new structure will extend from the present subway terminus at Whitlock Ave. to Pelham Bay Park. Foundations for the columns are already completed.

Power Legislation Once More Before Congress

Three New Water-Power Bills Introduced, and Funds Asked for Power Survey of Entire Country

Legislation providing for the opening up of the tremendous power possibilities of the country has been introduced into the new Congress. The legislation was defeated by the filibuster at the end of the last Congress. Water-power bills in three different forms have been presented to the Senate, and the House of Representatives has passed a rule providing for the creation of another special water-power committee similar to that which worked a bill through the house at the last session of Congress. The three bills introduced in the Senate are by Senator Jones of Washington (Senate 152), by Senator Walsh of Montana (Senate 220), and by Senator Shields of Tennessee (Senate 651).

The movement to obtain appropriations for a power survey of the United States is again under way. The estimates of appropriation presented by Secretary Lane of the Department of the Interior to the last Congress have been renewed, and are now before the appropriations committee of the House of Representatives. These appropriations would permit the Geological Survey to expend $250,000 in studies of power supply during the coming fiscal year. Of this amount $50,000 would be used in a general engineering and statistical survey of the power resources of the United States. The balance of the appropriation would be used for an intensive survey of power possibilities along the north Atlantic seaboard, where the power famine is greatest. Hearings will be started immediately before the appropriations committee of the House.

Federal Industrial Relations Commission Planned

A bill creating a Federal Industrial Relations Commission has just been introduced in Congress. If it is passed, a commission of four would be formed whose duty it would be to promote industrial peace and prosperity by dealing with the causes and conditions provocative of industrial discontent and unrest.

Functions as follows are delegated to the commission: (1) Exert its authority to relieve unemployment; (2) cooperate with Government departments to equalize and regularize employment opportunities; (3) establish standards of industrial relations for Government

departments in employment and purchasing; (4) represent the public interest in labor disputes; (5) promote and develop adjustment boards for the standardization of wages; (6) promote uniform legislation in all matters relating to industrial peace and welfare; (7) establish educational agencies for training administrators of employment; (8) maintain a personnel bureau for rating and listing labor administrators; (9) coöperate with the Departments of Commerce and Labor, and (10) report to Congress a plan for industrial insurance for old age, accident, injury, etc.

Each commissioner would receive a salary of $5000, and the commission would be composed of one employer of labor, one representative of wage earners, one economist, and one specialist in labor administration. One of these must be a woman. The regular term, after a graduated adjustment so that all will not retire at once, is five years.

Secretary of Labor Asks Continuation of Employment Service

Enactment of legislation to provide a permanent public employment service has been requested by Secretary of Labor Wilson in a letter of May 30 to Representative J. M. C. Smith, chairman of the House Committee on Labor, and Senator Kenyon, chairman of the Senate committee.

The Secretary asks that the United States Employment Service be continued as a permanent bureau of the Department of Labor, in charge of a director general to be appointed by the President. The plan embodies the suggestion for full coöperation with the various states.

Bill to Promote Engineering and Industrial Research

On May 20 the Gronna bill for the promotion of engineering and industrial research was introduced into the United States Senate. It provides that the Secretary of Commerce and the National Research Council shall be designated as a national board of engineering and industrial research. No compensation other than actual expenses of the members shall be paid. The board is to appoint in each state and territory a research board of "five engineers or scientists engaged in the development of engineering and industrial science" to have immediate conduct of the research provided for by the act, in their respective states or territories. Board members are appointed for five years, and an executive committee of six is provided for the purpose of coöperation, and to determine whether proposed investigations are new, needful and justifiable. A majority vote of this executive committee is required to authorize any research work along lines clearly outlined in the act. Bulletins are to be published giving results of investigations. The sum of $15,000 per annum is appropriated to the Department of Commerce and also to each state and territory.

Canadian Senate Passes Railroad Bill

Provides for Canadian National Railway Company To Operate Properties for Government Account

The bill incorporating the Canadian National Railway Co., passed by the Canadian House of Commons May 6, was passed by the Senate May 27 and will become law on receiving the assent of the Governor General. The bill provides that the Canadian National Railway Co. shall operate, for Government account, 31 major properties and 14 subsidiaries, included in the Canadian Northern System.

The bill recites that it is expedient to provide for the incorporation of a company under which the railways, works and undertakings of the companies of the Canadian Northern System may be consolidated and, together with the Canadian Government Railways, operated as a national railway system.

It provides that the Government may nominate not less than five nor more than 15 directors, who are incorporated under the name of "Canadian National Railway Co.," stock ownership not being a necessary qualification.

The Government may declare that the company shall have a capital stock, with or without shares, in such amount as may be deemed expedient, vesting the stock with the Minister of Finance. From time to time the Government may entrust to the company the management and operation of any railways or works controlled by the Government.

All expenses incurred in the operation and management of the company shall be paid out of Government revenues and, in the event of a deficit, the amount is to be paid by the Minister of Finance out of the consolidated revenue fund and included in the estimate submitted to Parliament. In the event of a surplus, the amount will be paid into the consolidated revenue fund.

The properties and works of a number of the constituent and subsidiary companies of the Canadian Northern System are declared by the bill to be "for the general advantage of Canada" and therefore subject to Federal and not provincial jurisdiction. Provision is made for the extension of the time of completion of a number of lines which the Canadian Northern System was authorized to construct, for two to five years. The company is given wide powers for constructing and operating transportation systems, for acquiring securities and obtaining advances, and for the issue of bonds, debentures or other securities for new construction.

Chicago Railway Electrification

A 15-year program for electrification of the Illinois Central R.R. at Chicago is to be included in the proposed ordinance for improvements along the south shore. As agreed upon by the railway, the Chicago commission on railway terminals and the council subcommittee on railway terminals, the ordinance is to provide that within five years after its passage the railway will have its suburban service operated by electricity, and within 10 and 15 years will have this extended to its freight service north and south of 12th St., respectively.

To Reinforce Niagara Arch Bridge for Heavier Traffic

Reconstruction of the Niagara railway arch bridge, which carries the tracks of the Grand Trunk Ry. across the Whirlpool Rapids Gorge, Niagara Falls, N. Y., has just been put under way, contracts having been let last week. The bridge as now existing has a designed capacity not exceeding Cooper's E40 loading. Traffic has so increased that reinforcement was thought advisable in order to bring the capacity up to modern loading and meet the growing demands of traffic over the bridge. The principal items of the revision are reinforcement of the floor steel of the main span and the trusses of the approach spans; placing a drainage floor on the railway deck to protect the steelwork and the highway floor; and renewing the highway floor. The cost of the work is likely to run up to several hundred thousand dollars. Contracts for the steel fabrication and erection have been let to the Lackawanna Bridge Co. and Terry & Tench, respectively. The work is being carried out for the corporation, the Niagara Railway Arch Bridge, under the direction of C. E. Fowler as consulting engineer.

Fifth National Exposition of Chemical Industries

The fifth national exposition of chemical industries will be held in the Coliseum and the First Regiment Armory in Chicago during the week of Sept. 22, 1919. As usual, there will be a number of society meetings held jointly with it. For these meetings, to be held in connection with the exposition, programs are in preparation, which include the meetings of the American Institute of Mining and Metallurgical Engineers, the American Electrochemical Society, the American Ceramic Society, and the Technical Association of the Pulp & Paper Industry. The office of the management of the exposition was changed June 1 from New York City to 417 S. Dearborn St., Chicago.

Missouri Road Bond Law Declared Constitutional

By a decision of the Supreme Court of the United States in a taxpayers' suit involving the validity of $3,000,000 worth of road bonds issued by St. Louis County, the Missouri road bond law has been upheld. This law authorizes county officials to issue road bonds and levy taxes therefor upon a vote of county residents. The Supreme Court declares the law to be constitutional. This decision will allow work in St. Louis County, which has been held up for several years, to go forward.

Engineering Council

Observations by National Service Committee

M. O. LEIGHTON, Chairamn
McLachlen Building, Washington, D. C.

An Engineer's Unfortunate Experience

Engineers who were enrolled in the Reserve Corps at the beginning of the war will be interested in the circumstances related below. How many engineers had a similar experience? All who did are urged to send a detailed statement to the National Service Committee. If the experience was common the combined testimony may be sufficiently strong to induce Congress to provide for reimbursement. It is not probable that corrective action can be secured on the basis of a few instances. Therefore, the engineers who have knowledge of similar cases and who fail to respond to this invitation may be depriving other engineers who are not so indifferent as to the consequences.

The following letter was addressed to the American Society of Civil Engineers by one of its associate members resident in the Philippines, and by progressive reference finally came to the Washington office of Engineering Council.

The American Society of Civil Engineers,
New York, U. S. A.

Dear Sirs:

As you are doubtless aware, the American Society during the recent war played a very considerable part in obtaining the services of engineers for the Army. Literature descriptive of the Engineer Officers' Reserve Corps was circulated throughout our membership and the society's appeal for men was probably responsible for a very large number of volunteers. In view of this fact, I am taking the liberty of advising you of certain instances in which the War Department, through the Chief of Engineers, seems to have violated the agreement under which the engineer officers were induced to offer their services. I am doing this with the hope that the society may be instrumental in securing legislation that will result in a partial reimbursement to the men for some of the financial loss that they suffered through certain rulings of the War Department.

Among other things, we were informed that reserve corps officers when ordered to active duty would receive the pay and allowance that officers ordinarily do when changing stations. Any number of Western engineers, several of them located in Alaska, applied for commissions in the first Engineer Reserve Corps. After their applications had gone forward the reserve corps was abolished by the War Department. Without receiving any information to this effect these men were telegraphed offers of commissions in the Engineers, U. S. A. They were accepted and ordered to Camp A. A. Humphreys, Virginia, for duty as students. Upon their arrival there they were informed that they would receive no travel allowances at all. The 7c. a mile that they expected was not due them because they had accepted commissions in the regular Army, not in the reserve corps. This was the first intimation that they had as to their new status. Most of the men, particularly those from Alaska, had been to a very considerable expense in traveling, as much as $350 in some cases, and naturally consider themselves unfairly treated.

Another instance, one which covers my own case, occurred as follows: Some 25 or 30 of us entered the service in the Philippine Islands. We were discharged in the States, most of us in the Eastern part. Our discharges came just too late to permit us to catch the December transport for the Philippines, so we were forced to wait for the January boat, which arrives in Manila about Feb. 15. We were thus over two months without pay, our Army pay having stopped on the date of our discharge and our pay as civilians not beginning until our arrival in the Philippines. Anticipating these conditions, some of the men requested that they be ordered to the Philippines and discharged there, or that they be returned to the inactive list in the reserve corps, so that they could return to their homes with pay. Both of these requests were refused, and the men discharged along with the rest.

Several of us called on various Army officials in Washington and were told in every case that new legislation was necessary before we could be reimbursed. It is to acquaint you with these facts and to solicit your assistance in securing the necessary legislation that I am troubling you with this letter.

We all received a letter of appreciation from Major General Black in which we were heartily thanked for the way in which we had responded to our country's call, etc. A little consideration in the orders getting us into and out of the service would have been more to the point.

On May 1 a letter was addressed to the Secretary of War in which the above communication was quoted, with a request as follows:

Will you be good enough to inform Engineering Council through the undersigned whether the facts as related in the letter above quoted are interpreted by the War Department in the same way as by Mr. ——— and whether there is an official intention to present the facts to Congress for the purpose of securing authority to reimburse discharged engineer officers of the Army whose experiences were similar to that above related.

Up to May 24 no response had been received from the War Department, but we have hopes. While the author of the above letter recites an unfortunate train of circumstances, which seemingly reflects discredit on someone, judgment should for the time being be tempered with consideration. This war has been so big a thing that the mental capacity of man has been quite inadequate to direct everything rightly. An injustice has been done, but the correction in this case lies not in placing the blame but in securing reparation. Our Government is essentially just and the Congress will not advisedly do injury to any man. Let us have all the facts.

Bill Raises Salary of Director of Bureau of Public Roads

The agricultural appropriations bill, H.R. 3157, which was introduced in the House of Representatives May 26, 1919, provides a salary of $6000 per annum for the Director of the Bureau of Public Roads. The salary heretofore has been $4500. The total appropriations in the agricultural bill amount to $31,691,562. Among appropriations interesting to engineers, there may be mentioned those for the Forest Service, amounting to $5,966,869, of which $450,000 is for use in improving the roads, trails, bridges, fire lanes, telephone lines, cabins, fences, etc., in the national forests; for the Bureau of Chemistry, $1,381,571, and for the Bureau of Public Roads, $594,320.

$1,000,000 Trust Fund Bequeathed to Philadelphia

The will of Thomas Skelton Harrison, former American minister and consul general to Egypt, which was recently probated in Philadelphia, provides a trust fund of nearly $1,000,000 to be used in improving conditions in the municipal government of Philadelphia. It provides for a board of seven men to apply the fund to various municipal needs.

Army Engineer Board to Recommend System of National Roads

A board of Army officers has been appointed to consider a system of national highways in connection with the rural post roads system, for which appropriations were provided in the postoffice appropriation bill, passed Feb. 28, 1919. The board will be directed to prepare specific recommendations, to be submitted for the approval of the Secretary of War. The board will consist of Gen. E. E. Winslow, of the Corps of Engineers, and Maj. J. M. Ritchie, of the Motor Transport Corps.

Bureau of Mines To Dedicate New Pittsburgh Laboratories

The new million-dollar laboratories and workshops of the Bureau of Mines in Pittsburgh, Penn., will be dedicated Sept. 29-Oct. 1. The feature of the dedication will be a national "safety-first" meet, at which teams of miners from all over the country will compete for a cup and medals for rescue work and first aid to the injured. As there is great rivalry among teams of various mining companies it is expected that these contests will take at least two days. At the last national "safety-first" meet held in 1911 more than 18,000 miners were present. The contests are open to all teams from mining and metallurgical industries in the United States.

New Water-Supply for Phoenix

Plans for a gravity mountain water-supply for Phoenix, Ariz., provide for a 42-in. pipe line 157,500 ft. long from the Verde River, with an infiltration system at the upper end, and discharging into a reinforced-concrete covered reservoir of 25,000,000-gal. capacity. The cost of the project is estimated at $1,350,000. These plans have been prepared and submitted to the city commissioners by L. B. Hitchcock, city engineer, and Hiram Phillips, consulting engineer, St. Louis, Mo.

Salt Lake City Has $890,000 for Water-Works Improvement

In the bond issue of $2,000,000 recently approved at Salt Lake City, Utah, the sum of $890,000 is assigned for improvement of the water-supply and distribution system, and it is expected that contracts will be let and considerable work done during 1919. A gravity high-line supply conduit from Parley's Cañon will cost about $300,000; this will be of reinforced concrete and will be 26,000 ft. long, with a daily capacity of 34,000,000 gal. Feeder mains for this conduit, 10 to 24 in. in diameter, together with ordinary water-main extensions, will cost about $240,000. Other items include $200,000 for purchase or exchange of additional sources of supply; $100,000 for the conservation of City Creek by constructing one or more small reservoirs; $50,000 for developing various sources of local supply for serving the parks. S. Q. Cannon is city engineer.

Constructive and Progressive Aspects of New Branch of Engineering

National Conference on Town and Regional Planning, Industrial Cities, Zoning, Steam Railroads

That town planning is municipal engineering at its highest level, embracing and coördinating the many and various elements in municipal design, becomes more evident with each National Conference on City Planning. At the eleventh of these gatherings, held at Niagara Falls and Buffalo, May 26-28, most of the subjects discussed were in the domain of the engineer, and engineers made up a goodly percentage of those present.

That the city planners are dealing with practical matters and are making progress in their work the country over is shown by the main features of the latest conference. These included discussions and reports on planning industrial cities, zoning in cities of all classes, regional planning to meet the needs of groups of cities and their tributary areas, and the steam railroads as related to both industrial and regional planning. Besides these four subjects, civic centers and soldiers' monuments were considered.

Hereafter the conferences will be continued more nearly along the lines followed for the first eight years than was contemplated two years ago when the American City Planning Institute was tentatively formed. Conference members of a year's standing may become members of the institute, which will be devoted to research work, provided they have been for at least two years in charge of some city-planning work of a major character. This work is so defined as to include both landscape and building architects, engineers and lawyers engaged in city planning. Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment, New York City, was elected as president of the conference for 1919-20, and was reëlected as secretary of the conference.

President Olmsted's Address

Lessons drawn from his war experiences in planning cantonments and war-industry housing projects were the chief features of the address of F. L. Olmsted, who retired as president of the conference after serving 10 years. The difficulties encountered in securing coöperation in a complex undertaking, Mr. Olmsted said, are not so much due to the work in hand as to the mental and moral inertia that keeps different persons from getting together. The two chief dangers are (1) excessive departmentalization, under which each does his part sequentially and independently instead of in coöperation, and (2) some one man assuming that he knows it all and trying to make all his associates his subordinates.

Turning to another phase of his subject, Mr. Olmsted said that, so far as he remembered his experiences with the United States Housing Corporation, Philadelphia was the only city that had clearly distinct street plans showing what thoroughfares are needed beyond the district limits. Still another remark by Mr. Olmsted that will appeal to engineers was his statement that any proper city engineering organization should have a staff, if only a single man, engaged wholly in planning for the future needs of the city.

Commenting on Mr. Olmsted's remarks, Arthur C. Comey, city planner, Cambridge, Mass., said that "however we may feel about it, municipal engineers are going to do a large part of town planning." This class of work will increase by force of the recent examples set by the Government, and there are not enough professional city planners to do it all. The city planning conference should bring in the municipal engineers.

Planning Problems of Industrial Cities

Growing attention is being given of late to the planning problems of industrial cities. These problems were outlined by John Nolen in a paper abstracted elsewhere in this issue, and they were specifically illustrated by wall plans from reports by Mr. Nolen on Niagara Falls, N. Y., Akron, Ohio, and Flint, Mich. Akron, Mr. Nolen said, has only one street extending clear through it unbroken, and that one is narrow.

Continuing this general subject and at the same time extending it into the field of one of the main topics, regional planning, Warren H. Manning, city planner, Boston, outlined a study he had made of the industrial-planning needs of Birmingham, Ala. The city has no up-and-down thoroughfares, only crossways. The adjacent villages, industrially related, should be connected with the city. Zoning is needed, and since the life of a building is 30 years, after which it becomes second-class, zoning for Birmingham is planned on the assumption that after 30 years the residence section on the lower level will become a manufacturing district, the houses going back to the higher levels.

As related to industrial planning, the rehousing operations of the Relief Commission of Halifax, N. S., were outlined by George A. Ross, of McDonald & Ross, Montreal, architects to the commission. Of 750 permanent new homes planned, some 200 are nearing completion. Although the devastated area was hilly, the original streets were laid out on the gridiron plan. Two diagonal streets have been provided to give better grades between the higher and lower levels. Street widths have been fixed to accord with grades, length and rise of streets. To give quick shelter, frame houses on a court-group plan were built. These will afford low-rent houses after their temporary occupants have moved. With a few variations in ground plan, 24 types of exteriors were secured for these group houses. A total of 110 individual houses has been built, and contract plans for 150 more are under way. Experience has shown that "hydrostone" or steam-cured hollow concrete blocks can be built for only 2.5% more than the cost of frame houses. The homes wrecked by the explosion two or three years ago were valued as of the date of the explosion. The relief fund bears the difference between their valuation and the actual cost of the new houses. In special cases, after careful investigation, aid is provided beyond that just mentioned. These statements apply to householders able and willing to acquire homes on mortgage.

The Steam Railroad and the City Plan

The relation of steam railways to the city plan was outlined by E. J. Fort, city manager of Niagara Falls, N. Y., and was also considered with special reference to that city by him and by Walter McCulloh, consulting engineer, Niagara Falls, and J. L. Harper, chief engineer of the Niagara Falls Power Co. Mr. Fort's paper is abstracted elsewhere in this issue. Mr. McCulloh reviewed four plans of railway relief prepared for Niagara Falls, those of the New York Central, the Grade Crossing Commission, John Nolen and E. P. Goodrich. Mr. Harper urged that in view of the great power developments of the future, resulting in a city extending to include Lockport, railway planning should cover more than the present small corner occupied by Niagara Falls.

The railroad problem was also discussed by J. E. Noulan Cauchon, engineer, Ottawa, Ont. As a matter of railway economics, Mr. Cauchon said, the railway problem is one of maximum tonnage on minimum grades, but the community requires safety and amenity as well. The speaker outlined railway relocations planned by him for Ottawa, Hamilton and London, Ont. These and the various plans for needed railway changes at Niagara Falls afford illustrations of one of the many city-planning activities of the day.

An Extension of City Planning

So important was regional planning considered by the framers of the conference program that an entire session was devoted to it. Papers were read by Thomas Adams on the general subject and by Morris Knowles on its more strictly engineering features. The paper by Mr. Adams is abstracted elsewhere in this issue. Regarding Mr. Adams' paper, it should be noted further that it included a detailed study of the Niagara Falls district on both sides of the international boundary, accompanied by maps and diagrams showing populations, resources and public utilities. Sewage-disposal prob-

lems of the region were discussed by T. W. Barraly, city engineer of Tonawanda, N. Y., who seemed to favor disposal through a combined sewage and power canal leading from Buffalo to Lake Ontario.

In general discussion, R. A. Pope, of New York City, said that regional planning is dependent on economic governing conditions and is therefore essentially within the province of the engineer. E. P. Goodrich, consulting engineer, New York City, said he was engaged in two regional studies that take into account the resources and export possibilities of the district.

Still another phase of regional planning, water fronts, came up at another session, when the Palisades Interstate Parkway of New York and New Jersey was described by W. A. Welch, chief engineer, and a proposed extension of the New York State Reservation at Niagara Falls so it would reach nearly the whole length of the United States side of the river—as does already the Dominion Reservation on the Canadian side—was outlined by Ansley Wilcox, of Buffalo. In this connection may be mentioned also a description of the proposed "peace bridge" across the Niagara River at Buafflo. A small appropriation for the study of this project was recently vetoed by Governor Smith of New York.

Zoning Progress and Policies

No subject evoked more interest, information and opinion than zoning. A supper session was devoted to brief reports on progress and an afternoon to residential zoning. Among the cities that have enacted zoning regulations are New York, St. Louis, Los Angeles, Oakland, Alameda, Berkeley and Palo Alto. Zoning for some cities has been authorized by the legislatures of New York, Pennsylvania and Nebraska, and by constitutional amendment in Massachusetts. Zoning regulations are being framed or are seriously proposed in Cambridge, Mass.; Buffalo, Cleveland, Detroit, Spokane, Portland, Ore.; San Francisco and other cities. A summary of the facts on zoning progress brought out at the conference may be obtained from Herbert S. Swann, 277 Broadway, New York City.

Archer C. Comey, of Cambridge, Mass., who opened the discussion on residential zoning, said that zoning as a whole is the largest single element in city planning. He thought that zoning regulations should be simple and drawn to last for 25 years. Zoning will stop four-fifths of the billboard nuisances in residential districts.

Charles H. Cheney, of San Francisco, held that regulations should be changed frequently to meet changing conditions. He urged that residence, business and industrial zones are necessary to insure reasonable rentals to wage earners. Unless land owners know that a given area will be restricted to residences they will insist on wide streets and heavy pavements suitable to business districts, thus increasing the price of lots beyond what low-priced dwellings can stand. The fundamental data for zoning are costly but necessary. They can be obtained in large part from the telephone companies, which are compelled to plan 20 years ahead. In establishing zones, neighborhood opinion should be secured, Mr. Cheney urged. This serves not only as a guide, but when brought out unmistakably is an argument that convinces the city councils that finally enact zoning ordinances. In Berkeley the Chamber of Commerce fixed the limits of the business district and the Manufacturers' Association set the bounds of the industrial zone. Harland Bartholomew, engineer of the St. Louis Planning Commission, said that zoning is a matter of four-fifths fact and one-fifth judgment. The facts should be put on paper, after which the plan can be worked out.

Civil Centers in Theory and Practice

A paper on the "Common Sense of the Civic Center," by Nelson P. Lewis, New York City, is abstracted in this issue. The group plan at Cleveland, on which more than $15,000,000 of obligations for land and buildings have been incurred, was described by Robert Hoffmann, city engineer. A county court house, a city hall and a Federal building have already been completed as parts of the group plan; a municipal hall is under construction and a public library has been planned and partly financed. Most of the large area of land for the mall has been acquired but not all of it has been cleared and, as the buildings thus far erected are scattered, the large outlay already incurred does not make a unit impression on either stranger or citizen. Perhaps, Mr. Hoffmann suggested, this was one reason why the voters recently agreed to a radical change in the plan for the location of the union station.

In a talk on "Soldiers' Monuments in Relation to the City Plan," by H. E. Jackson, of the Bureau of Education, Washington, D. C., it was urged that these express the spirit that animated the soldiers; also that it would be well to defer for some years, as have the French, attempts at works of art, since it is too early as yet to work out properly the ideals suitable for permanent war memorials of a purely artistic character. Speaking along other lines, Mr. Jackson pleaded for community or neighborhood organization and for social engineering. Four or five universities are considering courses for training social engineers, he said, and one has already decided to establish such a course.

Before adjournment the conference adopted resolutions urging the Bureau of the Census to adopt, for cities of 10,000 or more, the same districts or multiples of the same as were used in 1910; requesting the Secretary of Labor to urge mayors of all cities to appoint city-planning commissions; and asking the board of governors of the city planning conference to appoint a committee to study regional planning.

Finally, the city planning conference was notable for its large attendance and sustained interest through almost continuous sessions for two and a half days, for its social luncheons and dinners and, last but not least, for its undoubtedly favorable reaction upon both Niagara Falls and Buffalo, each of which is awakening to its great need for city planning. This reaction was especially notable in Niagara Falls, where the newspapers and some of the people are beginning to realize how little man has done for the convenience and amenities of a city for which nature has wrought on so grand a scale.

Dust Explosion in Grain Mill Causes Serious Damage

Nearly 50 persons were killed and about $3,000,000 worth of property was destroyed May 22 as a result of a dust explosion in the feed-grinding mill of the Douglas Corn Products Co., at Cedar Rapids, Iowa. A consequent fire caused much of the damage. Experts from the Department of Agriculture are making an investigation.

Dallas Engineers Get Together

The Dallas Chapter of the American Association of Engineers was installed May 25 by C. E. Drayer, national secretary. The meeting was attended by nonmembers, and resulted in the starting of a Dallas Engineers' Club, to include all engineers of that city. A committee is being formed, composed of representatives of all national societies, to study the situation and to report with recommendations. The suggestion for an all-inclusive local club was made by Jacob H. Brillhart, representative of the Texas Association of Members of the American Society of Civil Engineers.

Licensing was indorsed unanimously, and a committee was appointed to go over the bill drafted by the Texas Association of Members of the American Society of Civil Engineers. All engineers in the state will be enlisted to support the final bill.

Civic activity, publicity, legislation, compensation, national and local organization were discussed. The suggestion that there be an all-inclusive democratic national organization that could speak with authority on public questions and speak with a voice that would be heard was heartily applauded. The thought was expressed that such an organization should be parallel in form to our political government, so that proper contact could be developed for political activity.

Civil Service Examinations

California.—Civil engineer, grade IV, $2700 to $3900 per year; examination in Sacramento, San Francisco and Los Angeles as soon after June 14 as possible. File applications with State Civil Service Commission at Sacramento before June 14.

California.—Construction engineer (civil engineer, grade III), $2100 to

$2700 per year; examination in Sacramento, San Francisco and Los Angeles, June 20. File applications with State Civil Service Commission at Sacramento before June 14.

California.—Civil engineer, grade II, $1500 to $2100 per year; examination in Sacramento, San Francisco and Los Angeles, June 20. File applications with State Civil Service Commission at Sacramento before June 14.

California. — Senior engineering draftsman, grade II, $1500 to $2100 per year; examination in Sacramento, San Francisco and Los Angeles, June 20-21. File applications with State Civil Service Commission before June 14th.

New York.—Heating and ventilating engineer, office of state architect, $1500 to $2500 per year, June 28, apply to State Civil Service Commission at Albany for application forms before June 16.

United States

For United States civil service examinations, listed on the following page, apply to United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

Senior engineer and senior architect, Interstate Commerce Commission, $1800-$2700 per year, June 10. File application before June 10.

Assistant designing engineer, Naval Ordnance Plant, South Charleston, W. Va., $9.20 per diem. July 8. File applications before July 8.

Valuation engineer, $3600-$4800 per year, and assistant valuation engineer, $2500-$3600 per year; technical staff, income-tax unit, Bureau of Internal Revenue, Treasury Department. No date specified.

Master computer, $2400 to $1800 per year, computer (Grade I) $1800 to $1400 and computer (Grade II) $1400 to $900, Ordnance Department. Applications will be received until further notice.

Calendar

Annual Meetings

AMERICAN WATER-WORKS ASSOCIATION; 47 State St., Troy, N. Y.; June 9-13, Buffalo, N. Y.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 W. 39th St., New York; June 16-19, Detroit.

AMERICAN SOCIETY OF CIVIL ENGINEERS; 29 W. 39th St., New York; June 17-20, St. Paul-Minneapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS; University of Pennsylvania, Philadelphia; June 24-27, Atlantic City, N. J.

AMERICAN CONCRETE INSTITUTE; 6 Beacon St., Boston; June 27-28, Atlantic City, N. J.

ENGINEERING SOCIETIES

The San Francisco Association of Members of the American Society of Civil Engineers made an inspection trip to the Mare Island Navy Yard May 24. About 60 members of the association made the trip, and were taken in automobiles to the various points of interest on the island, including the 150-ton floating crane, an electrically welded steel barge, the construction of battleships and destroyers, the operation of electric furnace, foundries, large machine shops, etc.

The Western Society of Engineers was addressed June 2 by Maj. Robert I. Randolph, 535th Engineers, Service Battalion, who spoke on his work in France in heavy railroad construction in the Toul sector. Capt. Paul Hansen, Sanitary Corps, U. S. A., who also served in the Toul sector, spoke on problems in connection with supplying the troops with water. On June 20 and 21 the society will celebrate its 50th anniversary. On the first day, engineering progress during the past 50 years will be the topic of discussion, and on the following day there will be a basket picnic at The Dunes.

The Engineers' Club of St. Louis held a joint meeting May 28 with the St. Louis Section of the American Institute of Electrical Engineers. The meeting was addressed by H. Weichsel, chief designing engineer, Wagner Electric Manufacturing Co., who spoke on "Insulation Resistance of Electrical Machinery," and by Prof. A. S. Langsdrof, dean of the schools of engineering and architecture, Washington University, on "Circulating Currents in Direct-Current Armatures and on Phase Relation in Interconnected Polyphase Systems."

The Technology Club of Syracuse, N. Y., held its annual meeting June 2. A dinner was given in honor of members who have returned from military service, each of whom spoke briefly of his experiences. The following officers were elected: President, Prof. Louis Mitchell; vice-president, Charles C. Trump; secretary, K. V. Farmer; treasurer, Marshall B. Palmer.

The Pittsburgh Chapter of the American Association of Engineers' banquet and ball. May 27, in honor of engineers returned from the Army and Navy, had Major Gen. William M. Black, Chief of Engineers, U. S. A., as the honor guest and principal speaker. About 200 guests were present. The Engineers' Society of Western Pennsylvania and and the Pittsburgh Association of Members of the American Society of Civil Engineers coöperated in the program.

The Civil Engineers' and Inspectors' Union, affiliated with the American Federation of Labor, was recently organized in Boston, with the following officers: President, Percival H. Mosher; vice-president, Frank McLaughlin; financial secretary, Leo S. Stone, 108 Waumbeck St., Roxbury; treasurer, William J. Cochran. The headquarters of the organization are at 3 Boylston Place, Boston.

The Southern California Association of Members of the American Society of Civil Engineers held a meeting and dinner May 14, at which the Hon. W. A. Johnstone, of the California State Water Commission, and the Hon. Jonathan S. Dodge, chairman of the Los Angeles County Board of Supervisors, were guests. Papers by F. H. Olmsted, Dr. Ford A. Carpenter and A. L. Sonderegger were read as a continuance of the symposium on flood control.

The Jackson, Mich., Engineering Society was addressed May 19 by W. L. Fox, of the Fox Machine Co., who spoke on the value of shop practice to draftsmen. A paper was read on "What the University of Michigan Extension Course Can Do for the Jackson Engineers."

The Oklahoma Chapter of the American Association of Engineers was installed June 2 by C. E. Drayer, secretary of the national organization. The officers of the chapter are: President, Fred L. Verity, and secretary, Erle K. Ramsey, office engineer, Oklahoma City.

The Society of Engineers of Topeka, Kan., held a regular meeting May 29, at which O. W. Griggs, valuation engineer, Santa Fé R.R., spoke on the subject of evaluation.

The Pennsylvania Railroad Section of the American Association of Engineers will hold its first annual meeting in Pittsburgh June 28. The headquarters of the section are at 1318 Fulton Bldg., Pittsburgh.

PERSONAL NOTES

MAJ. FRANK M. MASTERS, U. S. A., has received his discharge from the service and has opened offices for the practice of engineering at 204 Locust St., Harrisburg, Penn. Major Masters was inspecting manager, Philadelphia Ordnance District, and recently served as a member of the Philadelphia Claims Board.

LIEUT. F. H. DECHANT, U. S. N. R. F., formerly civil engineer, Bureau of Yards and Docks, Navy Department, at Quantico, Va., has obtained his release from active duty and is transferred to the inactive list. He has become associated with WILLIAM H. DECHANT & SONS, civil engineers, Baer Building, Reading, Penn.

M. J. SCAMMELL has resigned as assistant general manager of the Sparrows Point, Md., plant of the Bethlehem Steel Corporation. He has been connected with the plant since 1912, when he was appointed superintendent of

blast furnaces. In the reorganization in 1916, when the Bethlehem Corporation took the plant over, he became general superintendent of the steel mill and later was made assistant general manager of the plant.

FRED J. DEUTSCHMANN, Aurora, Ill., whose appointment as city engineer of Mitchell, S. D., was noted in *Engineering News-Record* of May 22, 1919, p. 1039, has not accepted the appointment, but will continue with the Wells Engineering Co., of Aurora, in charge of the construction of municipal and sanitary work.

CAPT. L. R. TILLOTSON, LIEUT. JAMES IRONS, and RAY A. FINNEY, all of whom have received their discharge from the 110th Engineers, U. S. A., have become associated in partnership under the firm name of the SHAWNEE COUNTY ENGINEERING Co., Topeka, Kan., and will specialize in highway engineering.

E. G. LANE, who was appointed chief engineer of the Baltimore & Ohio R.R., Lines West, in September, 1918, from the position of engineer maintenance of way, has been appointed with jurisdiction also over the maintenance-of-way department of the Baltimore & Ohio, Lines West, including the Dayton & Union R.R. and the Dayton Union R.R.

LIEUT. COL. GEORGE A. JOHNSON, Construction Division, U. S. A., and MAJ. WEBSTER L. BENHAM, Construction Division, U. S. A., have become associated in partnership under the firm name of JOHNSON & BENHAM, consulting engineers, with offices at 150 Nassau St., New York City, and the Pathfinder Building, Kansas City, Mo. Colonel Johnson, who is still in the service, but anticipates discharge in the autumn, was originally officer in charge of the water and sewer section in the Construction Division. He later became second in command of the maintenance and repair branch of the Construction Division. Major Benham received his discharge from the service May 1, having served as officer in charge of utilities and as construction quartermaster at Camp Funston, Kansas. He was later appointed regional supervising utilities officer for camps in the Southwest, and in March of this year was ordered to Washington as assistant to the chief of the Construction Division. The new firm will engage in general engineering practice.

CAPT. THOMAS GRIFFIN, Ordnance Department, U. S. A., who was recently discharged from the service, is now established at 2 Rector St., New York City, where he will engage in a general engineering business, specializing in the export of engineering supplies.

SEYMOUR CORLEY, 15th Engineers, U. S. A., recently discharged from the service, who was formerly connected with the Des Moines Bridge & Iron Co., has become superintendent of water-works and sewerage construction for Lawrence & McCann, general contractors, Eveleth, Minn.

CAPT. CHARLES DUBOIS, Construction Division, U. S. A., has received his discharge from the service and has become associated with the Bickle Co., engineers and contractors of Kansas City, Mo., and will specialize in highway construction.

C. E. BRASHEARS, formerly city engineer of Yakima, Wash., has been appointed inspecting engineer of the Yakima County sections of the Inland Empire Highway, which will be built this summer under the State Highway Department.

CAPT. LEWIS A. STEPHENSON, Ordnance Department, U. S. A., who was formerly stationed at Camp Funston, Kansas, has received his discharge from the service and has opened offices in Kansas City, Mo., for the practice of engineering.

G. CLYDE BALDWIN, engineer in charge of the United States Geological Survey office at Boise, Idaho, since 1911, has been transferred to Idaho Falls, in charge of the new office at that point.

CARL PAULSON, United States Geological Survey office, Atlanta, Ga., has been appointed engineer in charge of the office at Boise, Idaho, succeeding G. CLYDE BALDWIN, transferred to Idaho Falls, as noted above.

FRED CLECKNER has received his discharge from the service in the 309th Field Signal Battalion and has resumed his former work with GANNETT, SEELYE & FLEMING, engineers, Harrisburg and Erie, Penn.

DANIEL W. CHAMBERLAIN, assistant division engineer, California State Highway Commission, has been appointed assistant highway engineer for Fresno County.

E. C. CONNOR has been appointed chief engineer of public utilities of Dallas, Tex.

LEROY E. WOLFE, formerly of the Virginia State Highway Department, has become associated with the du Pont Co., Wilmington, Del.

W. B. SHORT, water department, City of Tacoma, Wash., has been appointed city engineer and manager of the water department of Bellingham, Wash.

A. R. SWEN, chief engineer, Iowa Railway & Light Co., Cedar Rapids, has resigned to become associated with H. R. GREEN, consulting engineer of Cedar Rapids.

J. B. CROLY has been appointed district manager, at Vancouver, B. C., in charge of the new office of the Dominion Engineering & Inspection Co., of Montreal.

B. H. MCCAMMENT and E. F. ERNEST, both of whom have received their discharge from the 110th Engineers, U. S. A., have become associated in partnership under the firm name of the FEDERAL ROAD ENGINEERING Co., Columbian Building, Topeka, Kansas.

LEONARD L. RYAN has been appointed manager of McCracken, Kansas.

OBITUARY

HENRY K. OWENS, consulting engineer, Seattle, died in that city, May 15, at the age of 61. He went to the Pacific coast in the employ of the engineering department of the Northern Pacific R.R. at the time of the completion of the line through to Seattle. He was afterward engaged in laying out the business district of the new City of Seattle after the fire in June, 1889. In recent years he had engaged in hydro-electric and irrigation development, including much work in the Columbia River district. At one time he was retained by the Northern Pacific as consulting engineer in the development of irrigation work in the settlement of reclaimed lands in Yakima Valley, Washington. He had made extensive studies in the possibilities of water-power and irrigation development in the Northwest.

PROF. ERNEST MARCEAU, president of the Polytechnic College, Laval University, Montreal, and chief engineer of canals, Province of Quebec, died at Sault au Recollet, Que., May 23, at the age of 60. He took his degree as civil engineer at Laval University in 1879 and joined the engineering department of the provincial Government. In 1894 he was appointed chief engineer of the Province of Quebec. For the past 10 years he served as president of the Polytechnic College.

FREDERICK T. CRANE, city engineer of Orange, N. J., for the past 25 years, died in that city, May 31, at the age of 65. For some years previous to his appointment as city engineer of Orange he had been engaged in railroad-engineering work. In 1916 he was nominated a member of the New Jersey State Department of Health.

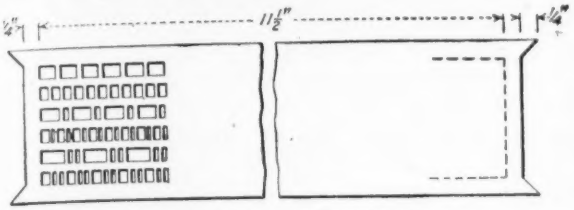
JOSEPH O. B. WEBSTER, for many years topographical engineer of New York City in charge of the laying out of streets, died in New York, May 30. He entered the service of the city in 1870 and for the past few years had been engaged in the engineering department of the Borough of Manhattan.

WILLIAM B. HOUGH, president of the Metal Building Materials Co., Chicago, died May 29. He was graduated from the Massachusetts Institute of Technology in 1900.

TIMOTHY M. RYAN, building contractor, of Seattle, died in that city, May 24. Mr. Ryan had been engaged in the contracting business during most of his 30 years' residence in Seattle.

Dot and Dash Lines Drafted by Simple Device

The drawing of uniform dot and dash lines may be accomplished by means of the simple ruling device shown in the accompanying illustration, which is formed by perforating very thin celluloid with rows of rectangles of varying widths. To manufacture the instrument celluloid of 1/100-in. thickness is used. This is punched with the



CELLULOID DOT AND DASH RULING DEVICE

desired spacings and then rolled into a bow shape.

The method of use is to place the celluloid over the drawing where a dotted or dot-and-dash line is desired, with the concave side of the bow downward. A straight-edge is then placed over the particular row of spacing desired, and a right-line pen is drawn over the celluloid touching the paper at the perforations. Upon removing the straight-edge, the spring in the instrument throws it upward from the paper. This prevents blotting.

The instrument is about to be placed on the market by the Defiance Manufacturing Co., of New York, which is the sole licensee under the patents.

Grand Central Palace, New York, to Become a World Trade Mart

Upon the return of the Grand Central Palace, of New York City, to the Merchants' and Manufacturers' Exchange, it is proposed to develop the building as a center for the extension of American commerce in foreign countries, as well as for the importation of foreign goods into America. The building, which is 12 stories high, was taken over by the Government for a base hospital, and is now being vacated.

Industries will be grouped and permanent exhibits placed on the eight upper floors. The four lower floors will be utilized for the annual expositions which have made the building famous heretofore.

Some of the permanent exhibits that will be installed in the near future include farm implements and tractors, hardware and home furnishings, mining machinery, railway equipment, textiles and printing machinery.

It is believed that such a building will be of great service to foreign buyers in expediting the selection of goods, and to domestic dealers and jobbers in selling. The office of the Merchants' and Manufacturers' Exchange is at 405 Lexington Ave., New York.

Union Meeting of Manufacturers of Handling Equipment

The Material Handling Machinery Manufacturers' Association, 35 W. 39th St., New York City, announces a coalition meeting of all manufacturers of mechanical handling equipment in the United States. The meeting will be held at the Hotel Astor, New York City, June 11, 1919. The invitation is extended to all manufacturers of cranes, winches and hoists; elevators; gravity and power-conveying machinery and apparatus; industrial trucks, tractors and trailers; bulk-handling machinery, and all makers of equipment and accessories such as storage batteries, bearings, rope for hoists, buckets, electric controllers and apparatus, etc. The advertising managers of the various companies are invited to hold a preliminary meeting at the Hotel Astor on Tuesday evening, June 10.

An interesting program has been prepared, at which speakers of national reputation will talk on the various aspects of coöperative advertising and promotion. A general "forum" discussion will be conducted in the afternoon. Further particulars can be obtained from Zenas W. Carter, secretary of the association promoting the meeting.

Business Notes

THE NEW YORK TESTING LABORATORIES, mining, metallurgical and chemical engineers, announce that they have opened new offices and laboratories in New York City, at 74-80 Washington St. In addition to its other work, this organization will specialize in inspection of materials at the source, and will act as consultants in smelting, foundry, drop-forging and heat-treating practices and in investigation of metallurgical shop troubles.

THE H. K. FERGUSON CO., Cleveland, Ohio, announces the appointment of Lieut. E. D. Stearns as sales manager. Before entering military service Lieutenant Stearns was a member of the Fort Pitt Engineering Co., of Pittsburgh.

THE EQUIPMENT CORPORATION OF AMERICA, Lumber Exchange Building, Chicago, Ill., announces the following changes in its organization: H. Grant Leonard, assisted by J. L. Shields, will be district manager of the Pittsburgh office, which has been moved to quarters in the Empire Bldg. Alfred Reynolds, formerly field salesman in the Chicago district, has been made Chicago district manager. The Philadelphia district branch office, in the Land Title Bldg., has increased its capacity.

THE SILENT HOIST CO. announces the removal of its New York office to 487 Broadway.

THE FERGUSON INDUSTRIAL CO. has been incorporated to transact a general contracting business, with main offices in the Spitzer Building, Toledo, Ohio. J. E. Ferguson is president and treasurer and P. H. Dexheimer is vice-president and field manager of the company.

THE MURRAY IRON WORKS CO., Burlington, Iowa, announces that F. C. Orrell has resigned as manager of the Minneapolis office of the Allis-Chalmers Manufacturing Co. of Milwaukee, to assume charge of the Chicago office of the Murray Iron Works Company.

THE ACME BLUE PRINT PAPER CO., 115 S. Dearborn St., Chicago, announces its entrance into the field as manufacturer and dealer in drawing materials, sensitized papers and blueprinting.

Trade Publications

The following companies have issued trade publications:

THE CLARK TRUCTRACTOR CO., 80 E. Jackson Boulevard, Chicago, Ill.; folder, 6¼ x 9¼ in., four pages, illustrated; describes a light three-wheel machine of 1½-ton capacity for industrial work; it can be used as a tractor or fitted with a box or dump body for carrying material.

THE S. G. H. RUBBER-STONE CO., Detroit, Mich.; booklet, 6 x 9 in., 19 pages., illustrated; subject, "The Modern Roadway," as built of "Rubber-Stone."

THE REDWOOD MANUFACTURERS' CO., Hobart Building, San Francisco, Cal.; catalog, 6¼ x 9¼ in., 115 pages, illustrated; describes the construction and installation of "Remco" Redwood pipe, and gives technical data in tabular form, covering such information as that necessary in proportioning water-power installations, capacity of pipe at various heads and with various diameters of pipes, discharge in gallons per minute and hour with velocity in feet per second, velocity head in feet and loss of head in feet per 1000 ft. of length, for sizes of pipe from 2 in. up to 144 in. in diameter.

THE STORMS MANUFACTURING CO., Crawfordsville, Ind.; folder, 3¾ x 9¼ in., 18 pages, illustrated; describes one-man collapsible steel forms for small and large concrete culverts for roads.

May Contracts Aggregate $100,000,000

Bids Wanted Now on 200 Projects—General Advance in Lumber—Prices at Several Centers

By Alden W. Welch

In bemoaning the slackness of the construction season it must not be overlooked that contracts let in May, alone, aggregated $100,000,000 and in number exceeded 1200. Furthermore, on May 29 bids were wanted on 203 projects. These projects will soon materialize as contracts awarded, in which event more than a thousand contractors will have plenty of new work for their organizations.

The need for construction in every field is so acute that the situation cannot be called satisfactory until all contractors are busy. The improvements in the past two months, however, are notable. The 655 contracts awarded in March aggregated $48,000,000, about half the record for May. The table shows the increase participated in by every department of construction. So noteworthy is the acceleration that no one branch can be singled out for particular commendation. Specially gratifying, however, is the activity in public works, as shown for sewers, bridges, roads and dredging.

ANALYSIS OF CONTRACTS LET IN MARCH AND MAY, 1919

Water-works	Sewers	Bridges	Streets and Roads	Excavating and Dredging	Industrial Works	Non-Industrial Buildings	Federal Government	Miscellaneous	
24	75	7	302	6	115	75	37	40	Number let in March
33	113	30	551	15	185	138	66	103	Number let in May
$710,000	$1,456,000	$117,000	$16,423,000	$698,000	$11,861,000	$11,617,000	$4,766,000	$1,081,000	Value of March contracts
$1,160,000	$5,145,000	$1,887,000	$27,866,000	$1,038,000	$22,672,000	$20,719,000	$6,204,000	$9,992,000	Value of May contracts

Better Demand for Steel

The demand for steel has improved. The failure of the Railroad Administration to break the price of rails has created a better sentiment in the industry. It is believed that the 200,000 tons reluctantly placed will be followed by further business from the railways. Other important orders were placed by automobile manufacturers, one being for 300,000 tons of billets, sheets, wires and tubes. Lower ocean freight rates have stimulated exports. As showing that the price is being maintained to Pittsburgh levels in England, a recent sale of billets was at $63, including ocean freight at $20. British billets are $67.28.

The most important price change since last month is in lumber, the rise being nation-wide. The high mark occurs in St. Paul, where 1-in. fir jumped $7 per 1000 ft. b.m. In the statement of conditions in the various centers of the country, which follows, the lumber situation is detailed. Lumber prices have not fluctuated in Chicago or St. Louis, and only slightly in New York, but Baltimore, Kansas City, Los Angeles, San Francisco and Seattle deserve attention.

Baltimore—The downward tendency in cost of building materials continues slight but steady, with its most noticeable effect in the cement and steel markets. Plain structural steel is being sold on the jobbing basis at $54 a ton, f.o.b. Baltimore, or $2.70 per 100 lb., with bar sizes and shapes under 3-in. at 10c. less; fabricated steel is being offered at prices varying according to whether light or heavy, but averaging $90 to $95 a ton; for floor-beams and columns $90 to $100 a ton is asked. These are decided drops over April. Cement, sold a month ago at $3.45 per barrel in more than 5-bbl. lots, can now be had at $3.10 a barrel.

The lumber market, apparently, is experiencing the most fluctuation, prices for the various grades rising and falling, on small margins, in sensitive touch with the law of supply and demand. At this writing lumber (common) is bringing $42 to $46 per 1000, delivered from local yards in city; heavier timber, up to $54, delivered. Common brick, sand and gravel prices have not changed since last month.

St. Paul—Recent bids show decreases in the following commodities: 3½-in. creosoted wood block, from $2.20 to $2.13 (St. Paul specifications); natural Austin cement, $1.55 to $1.45; brick paving block, $37.50 to $36.50. There is a slight increase all along in lumber, the most notable being a jump of $7 in 1-in. rough fir, and $4 in 8 x 8-in. pine.

Kansas City, Mo.—Crushed stone has advanced from $1.70 and $1.80 for 1½- and ¾-in., respectively, to $1.90 and $2; common brick, from $14 to $15; yellow pine, 1 in., rough, 10 in. and under, 16 ft. and under, has jumped $2.75 per 1000, and yellow pine, 2-in. t. and g., dressed and matched, same sizes, has advanced $1.50. These advances are due to an active "Build Now" campaign. The *Star* of Sunday, May 25, contained 60 want ads for carpenters, several for from 25 to 60 men.

Lumber Stocks Oversold

Many of the Southern and Western lumber mills have withdrawn from the market because they have oversold their stocks to a point where it will require the accumulation of the next 30 to 60 days to cover present orders. The present ocean rate of lumber of $51.75 per 1000, as against a pre-war rate of $9, is causing foreign private concerns to hold back on orders now.

Lumber firms controlling large Southern mill interests say that if the rate drops as expected—to about $40 by Sept. 1—lumber will go to the highest bidder, and it is expected that the European demand will be so great that an abnormal advance at home will follow. Stocks of all kinds of lumber in the hands of manufacturers today are said to be the lowest in history. Foreign governments, which are demanding lumber of all grades and sizes, are glad to get it at the present market price, despite almost prohibitive freights.

Public work has been retarded in the past few weeks by unfavorable weather conditions. It is improving, however. Many very large contracts, especially sewers, one for $1,500,000 and another for $2,500,000; also a diking project of $1,000,000 will be ready for letting by the city in the near future.

San Francisco—The rise in lumber prices is said to be due to increased demand. Mill owners claim they were not making sufficient profit, so they advanced their prices as soon as the demand warranted. The new prices are published in the section following this article.

Los Angeles—With a steady increase in the volume of building and engineering operations, and with the prospect of a labor shortage, no reduction in the price of construction materials is looked for in Los Angeles. Lumber prices have advanced about $4. Prices of other materials, with the exception of a few like explosives, rope, etc., remain steady. These exceptions show reductions in price, due, no doubt, to the creation of a surplus through the cessation of hostilities. Building construction, street and highway work, irrigation, drainage and sewer installation and hydro-electric development are all back practically to a pre-war stride.

Seattle—Between Apr. 23 and May 23 the price of lumber, wholesale, carload lots, to dealers, f.o.b. Seattle, best grade only, advanced from $17.50 to $20.50. This increase is attributed to steady demand from all parts of the United States and the growing number of orders from Europe. There is a decided shortage of stocks. Mill stocks are practically depleted and production is below normal. Official figures show orders are about 10% above normal, production about 10% below normal, and shipments about normal.

Contract prices for recent work have averaged 10 to 15% below those of last year. Conditions generally seem to be more stable and contractors are showing much more interest in bidding.